Health Care Financing Conference Proceedings

Issues in Physician Reimbursement

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The mission of the Health Care Financing Administration is to promote the timely delivery of appropriate, quality health care to its beneficiaries—approximately 47 million of the nation's aged, disabled, and poor. The Agency must also ensure that program beneficiaries are aware of the services for which they are eligible, that those services are accessible and of high quality, and that Agency policies and actions promote efficiency and quality within the total health care delivery system.

HCFA's Office of Research, Demonstrations, and Statistics (ORDS) conducts studies and projects that demonstrate and evaluate optional reimbursement, coverage, eligibility, and management alternatives to the present Federal programs. ORDS also assesses the impact of HCFA programs on health care costs, program expenditures, beneficiary access to services, health care providers, and the health care industry. In addition, ORDS monitors national health care expenditures and prices and provides actuarial analyses on the costs of current HCFA programs as well as the impact of possible legislative or administrative changes in the programs.

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Issues in Physician Reimbursement

Edited by Nancy Thorndike Greenspan

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Introduction
by Nancy Thorndike Greenspan

An index to adjust Medicare prevailing fees according to inflationary trends in the economy was specified in Section 224 of the 1972 Amendments to the Social Security Act. Congress provided the original formulation of the Index and gave the Secretary of the Department of Health and Human Services authority to refine it. It soon became evident that collecting primary data on physician practice characteristics and costs would be necessary to implement further refinements to the Index.

The Health Care Financing Administration (HCFA) funded surveys to collect data on physicians' costs and incomes for the years 1975 through 1978. In 1978, HCFA supported the analysis of these data. Although the major focus was the analysis of physician practice costs and incomes for use in refining the Medicare Economic Index, the breadth of the data allowed numerous other reimbursement issues to be addressed. This book contains the first reports emanating from this research.

These reports were presented in February 1980 at a conference organized by HCFA.[1] Eight major reports were given, each followed by comments by two reviewers. The reports and comments were then synthesized by a summary panel. This book contains the reports, comments and summaries.

1975 and 1976 Physicians' Practice Cost Survey

The 1975 Physicians' Practice Cost Survey, undertaken by the National Opinion Research Center (NORC), consisted of face-to-face or telephone interviews with 1,014 office-based physicians nationally and another 1,010 office-based physicians selected regionally. The sample was restricted to physicians in the largest specialties: general/family practice, internal medicine, pediatrics, general surgery and obstetrics-gynecology. The national survey, conducted in 32 Primary Sampling Units (PSUs) throughout the United States, is the more comprehensive of the two, having interviews lasting up to 90 minutes. The regional survey, based entirely on 20 PSUs in the Mid-Atlantic Census Division (New Jersey, New York, and Pennsylvania) and the East South Central Census Division (Alabama, Kentucky, Mississippi, and Tennessee) used a questionnaire about half the length of the national survey. (Final responses rates were 66 and 71 percent for the national and regional samples, respectively, or 68 percent overall.) General surgeons, obstetricians-gynecologists, and pediatricians are slightly overrepresented in the sample because of higher response rates with corresponding underrepresentation among general practitioners and internists. Also, foreign medical school graduates, board-certified practitioners, and older physicians were somewhat more willing to respond.

Listed below is a general description of the data on physicians' practices which were gathered for 1975. All data are self-reported.

1. Practice characteristics, such as whether the practice is incorporated, a partnership or group, or prepaid;
2. General socio-economic characteristics of physicians' patients;
3. Disaggregated office expenses such as rent, salaries, depreciation;
4. Office employees by type and salary;
5. Gross and net income;
6. Physicians' output measures by time spent in various medical services and number of services rendered;
7. Fee allowance by types of insurer for four or five procedures;
8. Insurance variables such as Medicare assignment rates, Medicaid participation, and patients' insurance mix;
9. Characteristics of physician's administrative billing procedures by type of insurer.

Two additional sources of data were merged onto the survey data: the Area Resource File, which contains demographic data by county, and the American Medical Association Master File, which contains physician-specific biographical information, such as age and board certification.

The 1976 survey, also conducted by NORC, was national in scope and interviews were conducted by telephone. The survey consisted of a randomly selected, non-clustered sample of 3,482 office-based physicians and 542 hospital-based physicians. The 1976 sample was expanded to include 17 specialties. They are: allergy, anesthesiology, cardiovascular disease, dermatology, general/family practice, general surgery, internal medicine, neurological surgery, obstetrics/gynecology, ophthalmology, orthopedic surgery, otolaryngology, and urology. The final response rate for the 1976 survey was 57 percent.

The categories of questions were primarily the same for both surveys. The differences in 1976 were the deletion of questions on administrative billing procedures and the addition of questions on sources of income (such as fee-for-service or salary), on some mix of medical services provided in the office, and on insurance variables (such as Medicare assignment rates and Medicaid participation).

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[1]Further research using the survey data has continued and will be available from HCFA shortly.

Conclusion

The reports and discussions that follow illustrate the richness and analytic potential of the primary data collected in the Surveys of Physicians' Practice Costs and Incomes. Although most of the analyses contain implications for reimbursement and, specially, for the Medicare Economic Index, in the main, they are diverse and self-contained papers, not unified by a common theme. However, the papers yield a number of major policy-relevant conclusions. A few examples are:

- Although the projected differences in specialty-specific indices for the Medicare Economic Index are statistically significant, the differences are small in absolute value;
- The Medicare Economic Index may offer financial incentives to the physician to prefer non-Medicare over Medicare patients;
- Blue Shield reimbursement levels and physicians' rates of participation in Blue Shield are higher when physicians have formal roles in the decision-making of Blue Shield plans;
- There is little difference in the quality of care provided at large Medicaid practices ("mills") and small ones; however, the physicians in large Medicaid practices have fewer credentials and lower hourly earnings than those in small Medicaid practices on average.

A Review Of The Medicare Economic Index: An Analysis Of Variations In Practice Costs Among Specialties

by Robert Berry

In the past, Medicare reimbursed physicians under the usual, customary, and reasonable (UCR) charge system which set maximum reimbursements for each procedure using the history of the physician's own charges and those of similar specialists in the nearby region. Since 1976, Medicare does not use the recent charge history to determine the physician fee screens but instead applies the current value of the Medicare Economic Index, a chained price index, to the 1973 prevailing charge rates. To date, due to the absence of sufficiently disaggregated data, only a single national Index value has been used to annually update the physician fee screens.

This paper uses the Survey data to test whether the Index weights, which are the cost shares in physician practices, differ significantly across specialty or across region. The paper then presents specialty-specific Index values using the specialty-specific weights and shows that although they are significantly different, that difference is quite small in absolute value. This result supports continued use of the single national Index. The paper goes on to discuss the estimation of translog cost functions and their possible direct use in price indices.

Description of the Medicare Economic Index

Inflation has persisted in the American economy for well over a decade, producing substantial increases in the prices of nearly all goods and services. The price of medical care has been no exception, increasing at a rate slightly higher than the overall Consumer Price Index (CPI). In the decade following the reference year 1967, the Bureau of Labor Statistics' CPI, not including medical services, increased approximately 80 percent, while the index of medical services more than doubled. This is an average annual increase over the decade of 6 percent for the nonmedical portion of the CPI and 7 percent for the medical portion. During this same period, the Bureau of Labor Statistics' (BLS) index for physician fees increased at a slightly faster pace than that for medical services as a whole.

The introduction of Medicare and Medicaid in 1965 rapidly expanded the Federal government's role in health care financing and has coincided with this increase in medical care prices. The resulting increase in Medicare budget expenditures brought pressure to control these prices. In response, Congress passed an amendment to the Social Security Act in 1972, designed to reduce the rate of growth in these expenditures, at least for physician services. The amendment broadly proposed to restrict the rate of increase of physicians' fees to the increase in costs which they faced. As the amendment took more precise form in regulation three years later, this restriction meant applying direct controls to increases in the prevailing charge rates by using the Medicare Economic Index. These prevailing charge rates established for each procedure a maximum reimbursement allowed for physician billing under Medicare. Previously, the distribution of recent actual charges had determined the updated prevailing charge rates, but the amendment and subsequent regulation severed that relationship by substituting the product of the current Medicare Economic Index and the 1973 prevailing rates.

To elaborate, the prevailing charge rates are part of the "usual, customary, and reasonable" (UCR) charge rate system which sets reimbursement rates for Medicare physician services. Under this system, the physician receives the lowest of the actual, customary, or prevailing charges, given certain "reasonable" allowances for variation in the actual service provided. The customary charge (Level I) is the physician's usual charge or, more specifically, the median

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charge for that service during the preceding sample or screen year. Customary charges lag behind current charges by several months due to the delay in sampling for the screen year.

Prior to the introduction of the Medicare Economic Index, Medicare carriers calculated the prevailing charge (Level II) for a given service by setting it equal to the 75th percentile of all customary charges, with each charge weighted by its frequency. The carrier grouped customary charges for similar specialists within a given locality. Under this system, increases in the actual charges increased the customary charge, albeit with a lag. They also increased the prevailing charge, if most physician charges were growing as was the case. Thus, the system had a built-in feedback link, as inflation in actual charges eventually increased both the customary and prevailing charges. Prevailing charges, which had been designed as the usual ceiling for reimbursement, reflected these steady increases in practice charges, which in turn reflected increases in practice costs and physician net income. The Medicare Economic Index was implemented in fiscal year 1976 to limit increases in prevailing charges by specifying an independent growth rate based on cost. Consequently, it severed this feedback link from increases in actual to prevailing charges.

In its present form, the Medicare Economic Index resembles a Laspeyres price index. Every price index form requires a method for weighting each constituent price. In the Laspeyres index, this weight is the quantity used in the base period, which produces what is commonly called a fixed-base price index. More concretely, the Laspeyres index is the ratio of two sums: in the base year or denominator, the sum of the product of each base year price and quantity, and in the subsequent year or numerator, the sum of the product of each subsequent year price and base year quantity. Because the Medicare Economic Index is used to measure the change in the price of inputs necessary to produce a physician office visit, the constituent prices in the index should be just these input prices or their proxies. The corresponding weights should be each input's base year quantity. In the Index, the inputs included are the physician's net income, non-physician employee wages, malpractice premiums, rent, supplies, auto expenses, and all other costs in a residual category. The index and its constituent values for the past four years appears in Table 1.

The equation below shows the two equivalent forms of the Index. On the left hand side of the equation is the form just discussed. On the right is the more commonly used equivalent—the sum of the products of the price ratio and the corresponding base year expenditure or cost share. This form is generally more understandable, and in this case more usable, because data are only available for price proxies and expenditure shares. In symbols these two forms of the Laspeyres are:

$$\frac{\Sigma p_{1i} q_{oi}}{\Sigma p_{oi} q_{oi}} = \Sigma \frac{p_{1i}}{p_{oi}} \frac{p_{oi} q_{oi}}{\Sigma p_{oi} q_{oi}}$$

where p and q refer to price and quantity, respectively, and o and 1 refer to base and subsequent year. The most commonly cited limitation of the Laspeyres index is its fixed base construction, which ignores the impact of relative price changes and the substitution among quantities this may induce in subsequent years. However, if all input prices increase more or less uniformly, substitution among inputs will be small, and the Laspeyres index will provide a good approximation.

In the first three years, the Medicare Economic Index took the form of a chained Laspeyres index: its base year weights were updated annually to reflect shifting patterns in shares of physician input costs. These weights are shown in Table 1. (The ratio of all non-physician factor input costs to net income has been held constant at two-thirds, but shares within the factor input portion have changed.) Thus, in each subsequent year the value of the Index equaled the product of the annual indices to date, each base-weighted in its own year. This product series constitutes the chain and introduces with a year's delay the substitution among input categories which results from the change in relative input prices. One can show formally that if a decrease occurs in the expenditure share of the input whose price has relatively risen (as expected), then over time the chained Laspeyres drifts away from the fixed-base Laspeyres but stays closer to the true index.

The application of the Index is relatively straightforward. Each base prevailing charge rate for 1973 is multiplied by the Index for the current year. As the years have passed and input price inflation has persisted, the value of this Index has naturally grown. Because only one Index is calculated, each prevailing charge rate has increased by the same percentage, and the relative position of each charge has remained the same. Thus far, due to the absence of detailed data, only a single national Index has been computed annually to update the charges of all specialties in all regions. To construct the Index, the Health Care Financing Administration (HCFA) before 1976 used cost share weights from published surveys. General BLS price and wage data have acted as proxies for actual physician input prices, except for malpractice premiums. We discuss the limitations of these approaches below. In Table 1, the ratios of the current year price and wage proxies to the year appear below the proxy values themselves; these ratios are the ones which enter the price index computation. Because the wage proxy for physician net income includes productivity changes, a productivity factor is subtracted and this net price increase is entered into the Index computation. By way of explanation, recall that the Index applies to fees for individual procedures, not total revenue. If improved physician productivity raises the rate of performing these procedures, then not eliminating this productivity proxy could allow total revenues to rise with increases in both individual fees and the number of procedures. This adjustment does assume that productivity gains are attributable only to the physician and affect the rate but not the nature of the procedures.

Because of the absence of available published data which would allow construction of specialty and region specific price indices, HCFA commissioned the Physicians' Practice Costs Survey to collect this data. The next section of this report discusses the calculation of these specialty and region-specific cost share ratios and price indices using the data from this survey. The data analysis assumes that the Index will retain its Laspeyres form. The subsequent section reviews alternative indices and their relative advantages.

TABLE I
Medicare Economic Index

	1971	1974	1975	1976	1977
1. Physician employees					
a. Wage					
1. Current proxy value	3.27	3.8200	4.1300	4.3600	4.6000
2. Ratio to previous period		1.1682	1.0812	1.0557	1.0550
b. Index weight		.1480	.1480	.1720	.1720
2. Rental Cost					
a. Price					
1. Current proxy value	124.30	150.6000	166.8000	177.2000	189.6000
2. Ratio to previous period		1.2116	1.1076	1.0624	1.0700
b. Index weight		.0560	.0600	.0400	.0400
3. Auto Expenses					
a. Price					
1. Current proxy value	116.60	136.6000	149.8000	164.6000	176.6000
2. Ratio to previous period		1.1715	1.0966	1.0988	1.0729
b. Index weight		.0240	.0280	.0200	.0200
4. Supplies					
a. Price					
1. Current proxy value	102.40	112.7000	126.6000	134.0000	140.5000
2. Ratio to previous period		1.1006	1.1233	1.0585	1.0485
b. Index weight		.0360	.0360	.0320	.0320
5. Other					
a. Price					
1. Current proxy value	121.30	147.7000	161.2000	170.5000	181.5000
2. Ratio to previous period		1.2176	1.0914	1.0577	1.0645
b. Index weight		.1360	.1120	.1080	.1080
6. Malpractice Premiums					
a. Price					
1. Current proxy value	—	—	—	—	—
2. Ratio to previous period	—	—	1.8400	1.4170	1.1030
b. Index weight	—	—	.0160	.0280	.0280
7. Physician Net Income					
a. Wage					
1. Current proxy value	122.28	154.4300	163.8900	176.2900	189.5300
2. Ratio to previous period					
a. Gross of productivity		1.2133	1.0611	1.0757	1.0751
b. Productivity measure		1.0133	1.0158	1.0375	1.0219
c. Net of Productivity		1.1999	1.0446	1.0368	1.0521
b. Index weight		.6000	.6000	.6000	.6000
Medicare Economic Index					
1. For indicated year		1.1901	1.0755	1.0544	1.0564
2. Cumulative to year		1.1901	1.2800	1.3496	1.4257

Cost Shares and Price Indices

As we indicated previously, the cost share numbers came from surveys published before 1976, while prices were drawn from BLS reports. Even if these provided accurate national estimates, they would still ignore any significant differences among specialty or regional cost shares. In this section, we begin to analyze the data from the Physicians' Practice Costs Survey. We present the cost levels and cost shares by both specialty and region. The multivariate analysis presented in the next section shows significant differences in cost shares among specialties and regions.

The Surveys in 1975 and 1976 included categories for most expense items. From the 1976 Survey, Table 2 presents the means and standard errors for each major cost category for all specialties included in the Survey. Although the median may be more representative of the typical physician, given the right skew of the cost distribution, the means and their standard errors do allow a fairly reliable comparison of cost levels in a given category across specialties. The major survey cost categories are rent (SPACE), medical equipment (EQUIPMENT), medical supplies (SUPPLY), malpractice premiums (MALPR), auto expenses (AUTO), nonphysician labor expenses, including pensions (NON-MD LABOR), and physician net income (MD NET INCOME), both with and without pension. The equipment category includes two alternatives: the actual expense from the 1976 survey (ACT 76) and an imputed expense using the 1975 Survey (IMP 75). (The distinction between these two and their use is explained below.) Total expenses include physician pension and the actual 1976 equipment expenses.

The Survey's seven cost categories match those in the Medicare Economic Index. Other cost categories are possible. For example, non-physician labor could be separated into medical and non-medical personnel. Equipment and supplies could also be separated, since they both reflect heterogeneous groupings. Determining the most appropriate Index breakdown requires a statistical test for consistency in aggregation among input types. If aggregation into fewer categories produces a significantly reduced explanation of total cost, then the most disaggregated form should be kept (Berndt and Christensen, 1974). However, such an approach demands specification and estimation of a cost function, a topic which we discuss later in Section IV. Usually those specifying the index approach the formation of separate cost categories less formally by adopting a conventional breakdown of costs (for example, capital, materials, labor, etc.). This conventional breakdown usually evolves from the production process in which inputs counted in similar units are aggregated (for example, hours of labor or square feet of floor space). Other simple criteria are available. Because of the fixed base form of the Laspeyres index, one can aggregate all input cost categories whose expected rate of price increases are nearly identical. Even if substitution within an aggregated input category does occur, the Laspeyres index will ignore it because the cost shares do not change. The Medicare Economic Index appears to have consistent groupings in the major cost categories with the heterogeneous categories of supplies and other expenses, accounting for 14 percent of total cost (Table 1). Thus, distortions due to incorrect categorization should be small. Finally, data availability constrains the cost categorization: further disaggregation would be very difficult because the Survey asked physicians to report on only the current index categories.

Another important issue in cost share analysis is the criteria for inclusion of cases in the sample. For those physician firms included in the sample, the total cost should be the minimum cost to produce the stated output. Not all firms need produce output at the global minimum cost point for errors in management to occur (for instance, in determining that point and in forecasting input prices). But at whatever the *expected* cost minimizing output and *expected* input prices, total cost should be a minimum. If not, the firms included represent a mix of efficient and inefficient firms. The criterion for excluding inefficient firms should depend on the particular market distortion which produces the inefficiency.

Several investigators have noted that most physicians have some market power because the very provision of diagnosis for fee violates one of the assumptions of the simple competitive model. The patient as consumer does not have access to free information to check the accuracy of the diagnosis or the quality of treatment, particularly in an acute case situation. Even in non-acute situations, the patient may only gradually realize if the service provided has been ineffective or excessively expensive. Other investigators have suggested that physicians are not price takers in their market for services and have substantial ability to raise fees, both through exercise of individual discretion and because of some patient insensitivity to higher fees due to relatively low co-payment rates.

Such market distortions only expand physician discretionary ability in price and quantity, but they do not argue against cost minimization *per se*. To maximize practice profits or even to maintain profits at some "satisfactory" level, the physician still has an incentive to minimize factor costs. Factor costs should include only the opportunity cost of the resources which the physician employs. For purchased inputs and employed labor, the opportunity cost usually equals the amount paid. If the distortions noted above exist, physician net income will include a return to the physician beyond the minimum which would have induced him or her to provide the services. In cost function analysis one should find a way to exclude either this return or, if that is not possible, the entire observation. Many physicians can charge higher fees which enable them to earn a higher net income, but this ability does not argue against their minimizing employed factor costs. It just produces a gross income which exceeds the sum of the opportunity costs of the resources. However, certain institutional characteristics might produce a distortion of the factor cost shares. For instance, the combined effect of recent increased inflation and current tax regulations may encourage current year overconsumption of tax-reported office space expenses

TABLE 2

1976 Cost Levels
(in thousands of dollars) — (15 specialties) — (standard errors in parentheses)

Specialty	N	Space	Equipment Imp.'75	Equipment Act. '76	Supply	Malpr.	Auto	Non-MD Labor	MD Net Income w/o Pens.	MD Net Income Pension	Total
Allergy	(55)	13.17	1.65	1.69	10.66	2.83	2.01	26.23	56.69	63.12	119.72
		(3.70)	(0.21)	(0.56)	(1.52)	(0.67)	(0.18)	(2.81)	(3.89)	(4.53)	(8.61)
Cardiovascular	(36)	11.38	1.27	1.76	3.93	4.57	2.56	20.51	60.67	67.74	112.45
		(3.21)	(0.25)	(0.59)	(0.79)	(0.69)	(0.23)	(3.09)	(4.13)	(4.62)	(8.18)
Dermatology	(64)	8.77	1.09	1.21	4.65	3.53	1.83	19.49	65.63	74.05	113.52
		(0.13)	(0.11)	(0.34)	(0.52)	(0.73)	(0.17)	(1.27)	(4.29)	(5.27)	(6.38)
Gastroenterology	(41)	9.24	0.92	2.65	4.03	3.38	2.00	16.65	57.85	64.51	102.47
		(1.71)	(0.17)	(1.08)	(0.82)	(0.44)	(0.18)	(2.49)	(3.72)	(4.24)	(5.86)
General Practice	(187)	7.62	1.29	1.81	7.43	3.67	2.07	20.95	49.06	53.22	96.77
		(0.74)	(0.10)	(0.36)	(0.69)	(0.44)	(0.10)	(1.17)	(1.73)	(1.92)	(3.22)
General Surgery	(164)	7.17	1.03	1.09	2.91	8.02	2.01	18.07	63.85	72.88	112.16
		(0.60)	(0.12)	(0.24)	(0.29)	(0.43)	(0.11)	(1.38)	(2.33)	(2.78)	(3.64)
Internal Medicine	(137)	7.68	1.20	1.50	5.72	2.66	2.01	19.74	59.20	65.94	105.23
		(0.46)	(0.10)	(0.45)	(0.83)	(0.28)	(0.12)	(1.29)	(2.24)	(2.47)	(3.87)
Neurolog. Surgery	(51)	8.52	0.95	4.11	2.04	11.10	2.59	19.04	82.23	95.19	142.59
		(0.73)	(0.15)	(1.80)	(0.67)	(0.87)	(0.24)	(2.19)	(4.68)	(5.58)	(7.21)
Ob/Gyn	(162)	8.90	1.25	1.33	3.81	9.78	2.00	20.84	70.01	78.99	125.67
		(0.93)	(0.12)	(0.18)	(0.33)	(0.56)	(0.11)	(1.60)	(2.35)	(2.70)	(4.14)
Ophthalmology	(78)	8.27	1.02	5.26	4.85	4.80	1.75	19.13	57.32	64.42	108.48
		(0.70)	(0.10)	(0.83)	(0.86)	(0.53)	(0.16)	(1.38)	(3.15)	(3.74)	(5.13)
Orthoped. Surgery	(56)	10.19	1.49	3.17	5.07	12.61	2.37	23.92	82.57	94.11	151.45
		(1.28)	(0.14)	(0.98)	(0.56)	(1.35)	(0.20)	(1.76)	(7.63)	(8.24)	(10.49)
Otolaryngology	(69)	8.38	1.18	3.30	3.99	8.35	2.02	21.89	59.91	68.48	116.41
		(0.75)	(0.15)	(1.00)	(0.96)	(0.75)	(0.21)	(2.11)	(3.21)	(3.84)	(6.14)
Pediatrics	(174)	7.90	0.97	0.77	5.75	2.44	1.89	16.58	47.36	52.72	88.05
		(0.54)	(0.07)	(0.15)	(0.57)	(0.24)	(0.11)	(0.82)	(1.54)	(2.21)	(2.95)
Psychiatry	(218)	6.36	0.39	0.26	0.41	1.17	1.62	7.65	49.87	55.01	72.48
		(0.68)	(0.10)	(0.05)	(0.08)	(0.10)	(0.08)	(1.22)	(1.62)	(1.83)	(2.79)
Urology	(54)	11.38	1.03	2.52	3.69	7.82	2.39	18.28	64.00	73.33	119.41
		(2.72)	(0.19)	(0.78)	(0.64)	(0.86)	(0.21)	(2.21)	(3.49)	(4.28)	(6.27)

through accelerated depreciation. Therefore, the rental share of expenses would not just be a function of current prices and output on the capitalization of the tax advantages. If minimization of current year cost does not describe physician firms, then one should interpret the multivariate analysis of variance of cost shares presented below as an analysis of expenditure shares. The price index then becomes an expenditure index.

For this report, we did not develop a method to identify physician firms that do not minimize cost. Such a procedure would require a careful examination of the distribution of cost at various levels of output. To exclude cases whose costs are in some sense "too high" requires a criterion to separate these cases from the remainder of the sample. This criterion should follow from specification of the particular distortion which leads to the non-minimizing behavior. In the future, we plan to develop some procedures to determine whether excluding these higher cost firms affects the analytic results.

Another aspect of sample formation concerns the culling out of selected cases which had internal data inconsistencies or data values which indicated errors in response or coding. As an example of the first type of inconsistency, we excluded cases in which the physician indicated a clearly unreasonable number of personal contact visits per hour. (For example, one allergist reported over 20 per hour.) As an example of the second type, we excluded physicians reporting no rent because of the strong possibility that they were hospital-based.

In Table 2, we show the average costs by category for the 15 specialties included in the office-based survey. These costs are on a per-physician basis. For solos this average cost is the firm's actual cost. For groups and partnerships, however, the per-physician calculation converts the firm's factor costs by dividing the firm's entire cost in each category by the number of full-time physicians (that is, those working 20 hours or more). The Survey limited the size of firms to 10 or fewer physicians, so the universe which we are analyzing consists of the smaller non-clinic practices. Because of data limitations in the Survey (described below), we completed all the statistical analysis on this per-physician basis. This approach will only create a bias in the estimation of cost levels if constant return to scale does not prevail across physician firms of increasing size. Previous work has revealed some economies of scale for rather small firms so that the cost levels presented in Table 2 may be biased somewhat upward (Kimbell and Lorant, 1977).

As indicated, data limitations within the Survey prevented using the firm level costs. These limitations were that the Survey did not cover the overhead cost category completely; it also omitted questions asking for accounting, bill collection, and legal expenses, as well as for general overhead expenses. We did attempt to estimate the omitted overhead expenses using data from the 1975 HCFA Survey which had exhaustively surveyed this area, but a variety of regression specifications did not explain much of the variation in overhead expenses. The column labelled "IMP '75" shows the predictions of 1976 overhead using as predictors employee wages and the number of office visits. Given the omitted data problem discussed above, the imputed expenses should be higher than the actual 1976 expense for equipment because the latter is only part of the former. However, the reverse is true.

For each of the 15 physician specialties, Table 3 displays the cost ratios for each of the seven basic input categories covered in the Survey. As stated above, these categories were not exhaustive, omitting overhead expenses from the residual category (labeled "other" in the Index, c.f. Table 1). Presently this category only covers equipment expenses (labeled "Equip." in Table 3), which constitute a relatively small part of this residual "other" cost category. Furthermore, physician net income includes pensions separately.[1] As might be expected, examination of Table 3 shows that malpractice cost shares are highest for surgeons as a group and highest for neurological surgery as a specialty. In general, the internal medicine specialties expend a larger proportion of total cost in employee wages. Other cost shares accord with expectations; the allergists' extensive use of supplies results in that cost share being highest for them. A set of one-way analyses of variance, which are unreported, shows that each of the cost ratios differed significantly across the specialty types. To analyze the complete impact of specialty on all cost shares simultaneously requires multivariate analysis of variance, presented in the next section.

Tables 4 and 5 reduce the number of specialties from 15 to three. These three categories are general/family practice, internal medicine and its related specialties, and surgery and its related specialties. This grouping recognizes that both surgeons and internists frequently mix general practice with various specialized work. Separating out the exact specialty content would be very difficult. If the Medicare Economic Index became specialty-specific with the specialty indices each having different cost shares, then physicians practicing in more than one specialty area would have the incentive to characterize their practice by the specialty having the greatest allowed price increase. Because of this potential problem, grouping of the specialities might make the implementation of a specialty-specific set of indices more feasible, with fewer disputes as to the choice of the appropriate Index.

[1] The Survey asked separate questions about pensions and net income. Some uncertainty arose about whether physicians included pensions in their statements of net income. We think not, because they appeared to answer other cost items in terms of tax deduction, and pensions are deductible. It is possible that they used tax deductions to estimate expenses, judging from their response to the equipment question. Those with no equipment expenses at all were found to be significantly older but not expending a significantly different amount in supplies or space.

TABLE 3

1976 Cost Ratios Using 1976 Equipment and Pension
(15 specialties) — (standard errors in parentheses)

Specialty	N	Space	Equip.	Supply	Malpr.	Auto	Non-MD Labor	MD Net Income Incl. Pension
Allergy	(55)	0.098	0.012	0.066	0.027	0.020	0.207	0.551
		(0.013)	(0.004)	(0.009)	(0.006)	(0.002)	(0.014)	(0.021)
Cardiovascular	(36)	0.093	0.015	0.035	0.045	0.027	0.168	0.618
		(0.015)	(0.004)	(0.006)	(0.006)	(0.003)	(0.022)	(0.024)
Dermatology	(64)	0.087	0.009	0.042	0.032	0.019	0.170	0.642
		(0.005)	(0.002)	(0.004)	(0.006)	(0.002)	(0.008)	(0.013)
Gastroenterology	(41)	0.093	0.025	0.039	0.034	0.023	0.158	0.630
		(0.012)	(0.009)	(0.007)	(0.004)	(0.002)	(0.018)	(0.003)
General Practice	(187)	0.080	0.015	0.072	0.037	0.025	0.208	0.563
		(0.005)	(0.003)	(0.005)	(0.003)	(0.001)	(0.008)	(0.010)
General Surgery	(164)	0.067	0.010	0.025	0.080	0.020	0.152	0.646
		(0.004)	(0.002)	(0.002)	(0.005)	(0.001)	(0.007)	(0.010)
Internal Medicine	(137)	0.078	0.011	0.047	0.026	0.023	0.179	0.637
		(0.005)	(0.002)	(0.004)	(0.002)	(0.002)	(0.007)	(0.010)
Neurolog. Surgery	(51)	0.063	0.021	0.013	0.085	0.020	0.131	0.667
		(0.005)	(0.008)	(0.004)	(0.007)	(0.002)	(0.003)	(0.018)
Ob/Gyn	(162)	0.069	0.011	0.029	0.082	0.018	0.162	0.630
		(0.004)	(0.002)	(0.002)	(0.004)	(0.001)	(0.007)	(0.009)
Ophthalmology	(78)	0.081	0.045	0.042	0.048	0.017	0.0178	0.589
		(0.006)	(0.007)	(0.007)	(0.004)	(0.002)	(0.011)	(0.016)
Orthoped. Surgery	(56)	0.073	0.018	0.034	0.088	0.018	0.166	0.604
		(0.008)	(0.005)	(0.003)	(0.007)	(0.002)	(0.011)	(0.015)
Otolaryngology	(69)	0.078	0.023	0.032	0.076	0.019	0.177	0.595
		(0.006)	(0.006)	(0.006)	(0.006)	(0.002)	(0.011)	(0.015)
Pediatrics	(174)	0.094	0.008	0.061	0.030	0.024	0.184	0.599
		(0.005)	(0.001)	(0.004)	(0.003)	(0.002)	(0.006)	(0.010)
Psychiatry	(218)	0.087	0.004	0.006	0.018	0.024	0.078	0.783
		(0.004)	(0.001)	(0.001)	(0.001)	(0.001)	(0.008)	(0.009)
Urology	(54)	0.093	0.021	0.030	0.067	0.023	0.146	0.620
		(0.013)	(0.006)	(0.005)	(0.006)	(0.002)	(0.012)	(0.022)

TABLE 4
1976 Cost Ratios
(3 specialty groups)
(standard errors in parentheses)

Specialty	N	Space	Equip.	Supply	Malpr.	Auto	Non-MD Labor	MD Net Income Incl. Pension
Internal Medicine	(333)	0.086	0.013	0.050	0.031	0.022	0.178	0.621
and Specialties		(0.004)	(0.002)	(0.003)	(0.002)	(0.001)	(0.005)	(0.007)
General/Family	(187)	0.080	0.015	0.072	0.037	0.025	0.208	0.563
Practices		(0.005)	(0.003)	(0.005)	(0.003)	(0.001)	(0.008)	(0.010)
Surgery and	(472)	0.074	0.021	0.029	0.074	0.019	0.159	0.624
Surgical Spec.		(0.003)	(0.002)	(0.002)	(0.002)	(0.001)	(0.004)	(0.006)

1976 Cost Ratios As a Share of Gross
Income For All Physicians
(3 specialty groups)

Specialty	(N)	Space	Equip.	Supply	Malpr.	Auto	Non-MD Labor	MD[1] Labor	Officers' Salary	MD Pension	MD Net[2] Income
Internal Medicine and Specialties	(208)	0.070	0.010	0.041	0.024	0.019	0.160	0.013	0.011	0.046	0.607
General/Family Practice	(106)	0.064	0.007	0.051	0.028	0.021	0.173	0.004	0.002	0.033	0.618
Surgery and Surgical Spec.	(306)	0.058	0.016	0.023	0.061	0.017	0.136	0.006	0.013	0.061	0.609

[1]Physician employee
[2]Physician solo, partner, or owner of corporation

TABLE 5
1976 Cost Ratios by Census Region
(3 specialty groups)
(standard errors in parentheses)

	Physician Income Including Pension				Malpractice Insurance			
	Region				Region			
Specialty	No. East	No. Central	South	West	No. East	No. Central	South	West
Internal Medicine	0.642	0.628	0.624	0.590	0.023	0.029	0.023	0.052
and Specialties	(0.013)	(0.017)	(0.014)	(0.016)	(0.002)	(0.004)	(0.003)	(0.006)
General/Family	0.623	0.563	0.574	0.502	0.030	0.036	0.033	0.056
Practice	(0.018)	(0.017)	(0.017)	(0.026)	(0.004)	(0.004)	(0.009)	(0.008)
Surgery and	0.645	0.631	0.653	0.584	0.084	0.073	0.053	0.098
Surgical Spec.	(0.001)	(0.012)	(0.011)	(0.015)	(0.005)	(0.004)	(0.003)	(0.016)

	Non-Physician Labor				Rental and Utility Expenses			
	Region				Region			
Specialty	No. East	No. Central	South	West	No. East	No. Central	South	West
Internal Medicine	0.156	0.184	0.193	0.188	0.092	0.079	0.079	0.093
and Specialties	(0.009)	(0.012)	(0.009)	(0.011)	(0.007)	(0.010)	(0.005)	(0.008)
General/Family	0.162	0.207	0.211	0.243	0.074	0.075	0.080	0.098
Practice	(0.018)	(0.013)	(0.012)	(0.020)	(0.008)	(0.007)	(0.007)	(0.017)
Surgery and	0.136	0.160	0.167	0.184	0.083	0.075	0.070	0.074
Surgical Spec.	(0.008)	(0.007)	(0.008)	(0.001)	(0.006)	(0.006)	(0.004)	(0.005)

The top half of Table 4 presents the cost ratios for the aggregated specialties using the per-physician costs. The bottom half shows the cost shares using gross income as the measure of total cost. To construct the cost shares in the bottom half, we formed the ratio of the individual costs and gross income for all shares except net income, which was derived as the residual cost. In the absence of another estimator, malpractice premiums were assumed identical for all physicians, which probably creates a distortion only for multi-specialty firms. To find the physicians' total cost share in the bottom half of Table 4 comparable to their share in the top half, sum the four right columns. Comparison of this sum with the physicians' share in the top table reveals a discrepancy ranging from 4 (internists) to over 8 (G.Ps.) percentage points. Probably much of this discrepancy is due to the missing overhead costs referred to above, which have ended up in the residual category Physician Net Income. Because of the difference in the price increase allowed the physician net income and other categories in the Index (that is, overhead, equipment, etc.), using the gross income approach shown in the bottom half of Table 4 would create a downward bias in the Index itself.

We hypothesized that physician firm cost shares differed across the major U.S. census regions as well as among specialties. For the three-way specialty breakdown discussed above, Table 5 shows the shares for the four largest costs—physician's net income, non-physician labor, rent, and malpractice premiums. The table indicates that the share going to physician net income is smallest in the Western region, while the malpractice shares are the largest because of the higher malpractice costs in the Western region. (We performed a similar analysis of cost share across the five major BLS population categories in tables not presented and discovered that rental expense shares increased with population, as did malpractice. The latter reflects the concentration of major medical centers in large SMSAs.) Because of the relatively small standard errors, cost shares appear to differ significantly across regions as well as across specialties. As in the case of specialties, a complete test of significant difference requires a multivariate analysis of variance test which is reported in the following section. To preview these results, significant differences do appear in cost shares across regions and specialties for both the three specialty and 15 specialty breakdown. Tables 3 and 5 indicate that the source of these differences comes from the relatively tight distributions (that is, relatively small standard errors) than from large differences among average shares. That explanation has important policy implications because it suggests that although region or specialty-specific indices are likely to be significantly different from one another, these differences are probably quite small in absolute magnitude.

Multivariate Analysis of Cost Shares

Multivariate analysis of variance (abbreviated MANOVA) allows the testing of the effect of one or more factors, such as specialty or region, on several dependent variables, such as several cost shares. In the standard one-way analysis of variance, the researcher tests the influence of one factor with two or more levels or categories on one dependent variable; an example would be a test of the influence of specialty on one of the several cost shares with each of the several specialties entering as different categories. In fact, during preliminary analysis of the data, such ANOVAs were performed on each cost share separately, and strongly significant differences appeared for all cost shares across specialties (all F-statistics were significant at the .001 level). MANOVA with one factor resembles several one-way analyses of variance performed simultaneously.

The following diagrams show the difference between ANOVA and MANOVA graphically. In one-way ANOVA, the test is equality of means for one factor, measured in the abscissa in the top diagram. In one-way MANOVA, the test is equality of several means, in this case two, measured on the ordinate and the abscissa. In the ANOVA diagram, one could specify X as physician net income and the μ_1 to μ_3 as specialty 1 to 3 means. In the MANOVA diagram, X_1 could be net income and X_2 malpractice premiums, with the ellipsoids containing the observations of specialties 1 through 3. In ANOVA, the null hypothesis of no effect is not satisfied if the distributions do not greatly overlap; in MANOVA it is not satisfied if the ellipsoids do not greatly overlap (diagram from Cooley and Lohnes, 1971).

FIGURE 1
The Simple ANOVA Situation, When the Differences Among the Populations Are "Real"

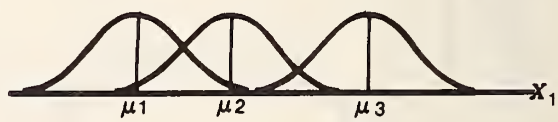
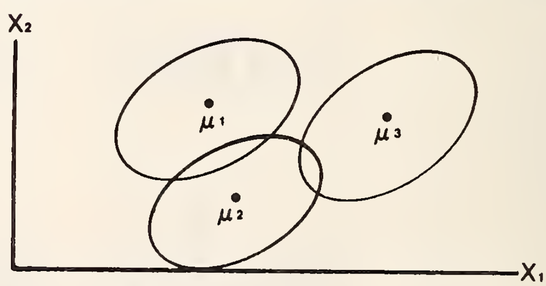


FIGURE 2
The Simple MANOVA Situation, When the Differences Among the Populations Are "Real"



MANOVA tests whether a factor has a significant impact on all the dependent variables taken together, in this case the cost shares. Not all cost shares are included because the cost shares by definition are constrained to equal one. It is sufficient to test whether the differences appear across all cost shares except one, and the test results are independent of which is omitted. More formally, MANOVA tests whether the six cost shares are simultaneously equal across all specialties; the hypothesis is of equal specialty effect vectors:

$$H_0 : \begin{bmatrix} r_{1,1} \\ \cdot \\ \cdot \\ r_{1,6} \end{bmatrix} = \ldots \begin{bmatrix} r_{15,1} \\ \cdot \\ \cdot \\ r_{15,6} \end{bmatrix}$$

The results of the MANOVA tests appear in Tables 6 to 12. As indicated in the preceding section, collapsing the number of specialties from 15 to three would allow easier implementation of specialty-specific Medicare Economic Indices because in both surgery and internal medicine, physicians frequently mix general and specialized practice work. Determining the exact specialty content of the work is difficult. Therefore, the first test determined whether homogeneity existed across these specialties. The results from Table 6 do not suggest much homogeneity even within internal medicine specialties or surgical specialties. Note again that the dependent variables in this analysis constitute the set of all cost shares less one; the cost share breakdown follows Table 3. The statistic used to test significance is Wilk's Criterion (Cooley and Lohnes, 1971).

Table 6 reveals that specialties should not be aggregated. Computational cost prevented specifying a complete MANOVA including all possible interactions, however, unless the three-way specialty aggregation (SPEC3) was used. This aggregation omits three specialties whose percent of patient practice receiving Medicare Part B is significantly lower: pediatrics, psychiatry, and obstetrics/gynecology (Table 7). The dependent variables in this analysis are still the set of all cost shares except one using the Table 3 breakdown.

In addition to the aggregated specialty variable, the MANOVA included as independent variables the region, population size, and practice type categorical variables. As discussed in Section II, the specialty and region variables were included because the prevailing charge rates currently vary across those dimensions. The population size category acts as a partial proxy for the influences of differential prices as might region. The practice type variables distinguishes only between solos and groups; this distinction is necessary because groups employ physician employees and may have greater opportunities for achieving increasing returns to scale (Separate MANOVAs indicated no effect for the influence of expense-sharing among solos or the equality of net income among group members.)

Examination of Table 8 shows that none of the interactions is significant at usually accepted confidence levels of less than 0.1, except for that between population size and region which falls between 0.1 and 0.01. The main effects of the variables region, specialty, and group are each strongly significant at a probability level of less than .001. The effect of the population size variable is significantly different from zero at a level not much above its interaction with region. In a somewhat arbitrary decision, this interaction was removed from later analysis, but we kept the population variable itself.

Although the full model was computationally too expensive with the complete 15 specialty breakdown, the model without interactions was computed for both that breakdown (SPEC15), an intermediate specialty aggregation (primarily aggregating specialists, SPEC 6), and for the three-way aggregation (SPEC3). We also included the number of office visits to account for the possible effect of scale economies on cost shares. Table 9 shows the distribution of hours spent outside the office. We included the percent of hours the physician spent outside the office to determine if greater hospital-based activity had a significant impact on costs. These two variables are highly correlated.

The F-statistic for Wilk's Criterion in Table 10 shows again that all main effects are significant at probabililty levels between .01 and .001. The variable office visits is also significant at this level, but SHAREOUT is not. The analysis is no longer a MANOVA but a MANOCOVA because the continuous variables office visits and SHAREOUT are included.

The results from these MANOVAs and MANOCOVAs demonstrate that cost shares do vary significantly across specialty and region. Cost shares also vary across population size categories which may reflect the influence of prices. Similarly, an increase in office visits also affects cost shares, but whether this indicates increasing or decreasing returns to scale is unclear.

Finally, two MANOCOVAs in Tables 11 and 12 interpret the effect of other characteristics. In Table 11, which is for groups only, F-statistics for Wilk's Criterion show that a multi-specialty group has cost ratios not greatly different from those in a single specialty group. Also, the presence of one or more physician employees does not create strong differences in cost shares. Table 12 has two interesting results. The F-statistic for Wilk's Criterion for the percent of patients having Part B Medicare (MEDICARE) is significant at the .0001 level: apparently practices with a larger percent Medicare patient load have a rather different distribution of costs. Column 2 shows that the ratio of the Medicare reimbursement (MEDFEE) to the usual charge for an office follow-up visit does not change the cost shares. This last result may be due to the low variation in the variable itself.

TABLE 6
Multivariate Analysis of Variance Results to Test for Homogeneity Within Specialty Groupings (Entries are the F-Statistics for Wilk's Criterion)

Specialty Groupings	F-Statistic[1]
1. Internal Medicine and Specialties (Numbers 1, 2, 3, 4)	3.06
2. Internal Medicine Specialties (Numbers 1, 2, 3, 4, 7)	2.65
3. Surgical Specialties—Office Based (Numbers 12, 14, 17)	2.52[2]
4. Surgical Specialties—Hospital Based (Numbers 8, 13)	5.30
5. Surgical Specialties (Numbers 8, 12, 13, 14, 17)	3.38
6. Surgery and Surgical Specialties (Numbers 6, 8, 12, 13, 14, and 17)	3.16

Specialty Numbers

1.	Allergy	7.	Internal Medicine
2.	Cardiovascular	8.	Neurological Surgery
3.	Dermatology	12.	Ophthalmology
4.	Gastroenterology	13.	Orthopedic Surgery
5.	General Practice	14.	Otolaryngology
6.	General Surgery	17.	Urology

[1]The F-statistics without a superscript have a probability level of less than .0001.

[2]p less than .01 but greater than .001

TABLE 7
Percentage Distribution of Medicare Patients by Specialty

	Percent of Patients Receiving Medicare Part B			
Specialty	0-5%	6-19%	20-49%	50-100%
Allergy	38.6	27.7	29.7	4.0
Cardiovascular	5.2	2.6	36.4	55.8
Dermatology	9.7	18.4	56.3	15.5
Gastroenterology	0.0	15.1	52.1	32.9
General Practice	11.4	21.8	47.0	19.9
General Surgery	5.8	17.2	57.1	19.8
Internal Medicine	4.8	8.4	45.8	41.0
Neurolog. Surgery	13.3	22.9	49.5	14.3
Ob/Gyn	68.0	20.2	9.6	2.2
Ophthalmology	5.5	9.4	46.5	38.6
Orthoped. Surgery	11.9	24.8	48.6	14.7
Otolaryngology	13.6	33.9	43.2	9.3
Pediatrics	96.3	1.7	1.3	0.7
Psychiatry	62.7	22.8	12.3	2.2
Urology	2.6	8.5	41.0	47.9

TABLE 8
The Effect of Specialty, Group, Region, and Population Size Catergories on Cost Share Distribution

Main Effects	F Statistics[1]
SPEC3	17.14[2]
GROUP	4.55[2]
BLSPOP	1.64[3]
REGION	3.86[2]
Interactions (2-Way)	
GROUP * SPEC3	1.35[4]
BLSPOP * SPEC3	0.96[4]
SPEC3 * REGION	0.96[4]
GROUP * BLSPOP	0.73[4]
GROUP * REGION	0.88[4]
BLSPOP * REGION	1.34[3]
Interactions (3-Way)	
GROUP * BLSPOP * SPEC3	0.73[4]
GROUP * SPEC3 * REGION	1.01[4]
BLSPOP * SPEC3 * REGION	1.12[4]
GROUP * BLSPOP * REGION	0.86[4]
Interaction (4-Way)	
GROUP * BLSPOP * SPEC3 * REGION	0.92[4]

SPEC3: Three specialty categories:
a. General Practice
b. Internal Medicine and Specialties
c. Surgery and Specialties
(no pediatricians, obstetricians, or psychiatrists included)
GROUP: Group or partnership/solo
BLSPOP: Five B.L.S. population categories (SMSA—based)
REGION: Four U.S. census regions

[1]The F-statistics without a superscript have a probability level of less than .0001
[2]p less than .001 but greater than .0001
[3]p less than .1 but greater than .01
[4]p greater than .1

TABLE 9
Proportion of Total Medical Hours Spent Outside the Office

Specialty	Mean Number Medical Hours
Allergy	0.311
Cardiovascular	0.597
Dermatology	0.274
Gastroenterology	0.589
General Practice	0.430
General Surgery	0.717
Internal Medicine	0.515
Neurological Surgery	0.771
Obstetrics/Gynecology	0.549
Ophthalmology	0.323
Orthopedic Surgery	0.615
Otolaryngology	0.498
Pediatrics	0.377
Psychiatry	0.375
Urology	0.672

TABLE 10
The Effect of Different Specialty Groupings and Other Variables on Cost Share Distributions

Effect	F-Statistic[1]					
	SPEC15		SPEC6		SPEC3	
SPEC	15.27[2]	11.45[2]	14.01[2]	9.99[2]	29.29[2]	19.99[2]
GROUP	11.35[2]	11.35[2]	7.48[2]	7.68[2]	8.01[2]	7.34[2]
BLSPOP	3.60[2]	3.18[2]	3.93[2]	3.50[2]	3.65[2]	3.28[2]
REGION	7.57[2]	7.17[2]	6.28[2]	5.90[2]	6.23[2]	5.97[2]
OFFICE VISITS		11.13[2]		10.55[2]		10.21[2]
SHAREOUT		2.40[4]		2.43[4]		3.23[3]

SPEC: Specialty groupings

SPEC15: 15 specialties:
Allergy, Cardiovascular, Dermatology, Gastroenterology, General Practice, General Surgery, Internal Medicine, Neurolog. Surgery, Ob/Gyn, Ophthalmology, Orthoped. Surgery, Otolaryngology, Pediatrics, Psychiatry, Urology

SPEC6: 6 specialty categories
Internal Medicine Specialties, General Surgery, General/Family Practice, Internal Medicine, Surgical Spec. Group I, Surgical Spec. Group 2

SPEC3: 3 specialty categories:
Family and General Practice, Internal Medicine and Specialties, Surgery and Surgical Specialties
(no pediatricians, obstetricians, or psychiatrists included)

GROUP: Group or partnership/solo

BLSPOP: 5 BLS population categories (SMSA-based)

REGION: 4 US census regions

OFFICE VISITS: Number of patient office visits

SHAREOUT: Percent of total hours at medical activites spent out of the office

[1] F-statistics without a superscript have a probability level of less than .0001
[2] p less than .001 but greater than .0001
[3] p less than .01 but greater than .001
[4] p less than .1 but greater than .01

TABLE 11
Impact of Various Practice Characteristics on Cost Share Distribution for Groups (N=296)

	F-Statistic[1]
SPEC3	4.70
BLSPOP	1.59[3]
MULTSPEC	1.72[4]
INCMDEMP	1.34[4]
OFFICE VISITS	.78[4]
SHAREOUT	3.13[2]

SPEC3: Three specialty categories:

a. General Practice
b. Internal Medicine and Specialties
c. Surgery and Specialties

(no pediatricians, obstetricians, or psychiatrists included)

BLSPOP: Five BLS population categories (SMSA-based)

MULTSPEC: Presence of more than one specialty in the group

INCMDEMP: Presence of physician employee in the group

OFFICE VISITS: Number of patient office visits

SHAREOUT: Proportion of hours spent outside the office

[1]The F-statistics without a superscript have a probability level of less than .0001.

The following superscripts imply these probability ranges:
[2]p less than .01 but greater than .001
[3]p less than .1 but greater than .01
[4]p greater than .1

TABLE 12
Impact of Medicare on Cost Shares

The effect on the distribution of cost shares of:

1. The ratio of Medicare reimbursement to physician's usual charge for office follow-up visit (MEDFEE)
2. The proportion of physician's practice receiving Medicare benefits through Part B (MEDICARE)

	F-Statistic[1]	F-Statistic[1]
GROUP	7.87	7.54
BLSPOP	3.78	3.50
SPEC3	18.44	17.14
SHAREOUT	2.67[2]	2.82[2]
OFFICE VISITS	10.80	9.69
MEDICARE	2.15[2]	—
MEDFEE	—	0.80[3]

GROUP: Group or partnership/solo
BLSPOP: 5 BLS population categories (SMSA-based)
SPEC3: a. Family and General Practice
b. Internal Medicine and Specialties
c. Surgery and Surgical Specialties
(no pediatricians, obstetricians or psychiatrists included)
SHAREOUT: Percent of total hours at medical activities spent out of the office
OFFICE VISITS: Number of patient office visits
MEDICARE: Percent of patients having Part B Medicare
MEDFEE: Ratio of Medicare reimbursement to physician's usual charge for office follow-up visit

[1]The F-statistics without a superscript have a probability level of less than .0001.
[2]p less than .1 but greater than .01
[3]p greater than .1

Another way to examine the differences in cost shares as a function of specialty or region is to aggregate these shares each weighted by a constant value across the sample. This aggregation of physician-specific shares might be called a share index. Table 13 confirms the existence of these relatively small differences among specialties for this share index. Computing a specialty-specific price index requires not only estimation of the average specialty-specific cost shares (which apply to all physicians in that specialty) but also requires the availability of the prices which those individual physicians faced. For each individual physician, the Index value is the product of own prices and specialty-wide cost shares. However, the Survey contained few measures of the input price facing physicians; in fact imputing the opportunity wage for physicians offers a separate challenge. Because our work did not extend to the imputation of prices, we choose to examine an alternative index value for each physician, one which we call the share index.

This index is simply the product of the physician's specific cost shares and the price ratios used in the Medicare Economic Index. The Index used only one set of price ratios so they remain constant across all physicians and across the entire nation, a somewhat unrealistic but necessary assumption given the unavailability of alternative region-specific or firm-specific prices. Consequently, Table 13 and 14 present analyses of the firm-specific share, not price, indices.

Variation in these share indices obviously does not reflect variation in prices but rather variation in cost shares. It provides a different approach for the analysis of the variation given the assumption of uniform prices. Instead of a simultaneous analysis in all the cost shares taken separately, the share index analysis offers a summary analysis of variation given the assumption of uniform prices. The two analyses, however, reach the same conclusion.

Both tables indicate that *strong* significant differences do exist among specialty region and population groupings. In Table 13, we show the specialty-specific share index implied by using both 1976 and 1977 price ratios. The 1976 Index price ratios reflected large increases in malpractice premiums. Because surgeons spend large shares on these premiums, their malpractice shares in 1976 are greater than those for internists. In 1977 the Index showed smaller price increases for malpractice premiums and, consequently, applying these ratios created smaller differences among the specific share averages. Under both price ratio assumptions, strong differences appear among the various specialties, indicating strong differences among their cost shares. Again, this is largely due to relatively tight distributions. The final row entry of Table 13 provides the overall measure of significance, the F-statistic for an analysis of variance of differences in share indices using the various specialty designations as categories. The size of the F-statistic indicates that differences exist at a probability level less than .001.

These significant differences appear across the population and region categories as well as among the specialties. Table 14 shows the share indices using the 1976 price ratio for the three specialty breakdown. Certain patterns emerge: surgeons' indices are consistently higher across regions and population categories. Again, the Western region has the highest Index value across the three specialties and nearly all population categories. Interestingly, the larger SMSAs do not consistently have the higher share indices. We completed a four-way analysis of variance of the effect on the share indices of four categorical variables—region, population, specialty, and group. The last variable simply distinguishes between solo and group practitioners. Except for the group variable, all factors are significant at the .001 level.

The final multivariate test excludes the effect of independent variables and simply asks whether the cost shares from the 1976 Survey differ significantly from the weights specified in 1976 for the Medicare Economic Index. A simultaneous t-test across all 1976 cost shares (except one) used the 1976 Index weights as the alternative and revealed, not surprisingly, that the cost share weights in the Index were significantly different from those in the 1976 Survey.

The first data column in the preceding table reports the 1976 Index weights. The second displays the estimated weights from the 1976 Survey using the actual equipment costs as a proxy for all overhead and equipment. The third shows the estimated 1976 Survey weights with a prediction of overhead/equipment expenses from the 1975 Survey. Finally, the fourth presents the 1976 weights having subtracted out 10.8 percent, which is the Index weight for "OTHER" (or overhead/equipment). With only one exception (the MD NET INCOME weight based on predicted overhead/equipment values), all individual t-statistics were significant at probability levels less than .002. In each instance, testing all cost shares simultaneously produced F-statistics with associated probability levels less than .001. The significance in the fourth column indicates that even holding constant the "OTHER" cost share does not eliminate the significant difference between the 1976 Survey and the Index Weights.

TABLE 13
1976 to 1977 Specialty-Based Share Indices for 15 specialties (standard errors in parentheses)

		Year	
Specialty	N	1976	1977
Allergy	(55)	1.0571 (0.0022)	1.0561 (0.0004)
Cardiovascular	(36)	1.0623 (0.0023)	1.0571 (0.0004)
Dermatology	(64)	1.0570 (0.0022)	1.0561 (0.0003)
Gastroenterology	(41)	1.0581 (0.0018)	1.0566 (0.0004)
General Practice	(187)	1.0605 (0.0013)	1.0565 (0.0002)
General Surgery	(164)	1.0737 (0.0018)	1.0582 (0.0003)
Internal Medicine	(137)	1.0549 (0.0008)	1.0558 (0.0001)
Neurological Surgery	(51)	1.0754 (0.0029)	1.0586 (0.0004)
Ob/Gyn	(162)	1.0748 (0.0016)	1.0584 (0.0002)
Ophthalmology	(78)	1.0634 (0.0017)	1.0572 (0.0003)
Orthopedic Surgery	(56)	1.0774 (0.0025)	1.0588 (0.0003)
Otolaryngology	(69)	1.0733 (0.0023)	1.0584 (0.0003)
Pediatrics	(174)	1.0571 (0.0010)	1.0562 (0.0002)
Psychiatry	(218)	1.0492 (0.0006)	1.0553 (0.0001)
Urology	(54)	1.0702 (0.0023)	1.0582 (0.0004)
F-statistic[1] for between-specialty analysis of variance	(1,546)	35.349	23.383

[1]F-statistic (14, 1,531) = 2.53 for probability $\leq$ .001.

Overall Cost Share (Hotelling T^2 in parentheses)

	1976 Index	1976 Survey Actual Equip.	1976 Survey Imputed Other	Index Equip.
Space	.040	.081 (25.63)	.007 (24.25)	.073 (23.08)
Equip/Other	.108	.014 (-114.53)	.062 (-72.55)	.108*
Supply	.032	.039 (5.69)	.037 (4.40)	.036 (3.16)
Malpractice	.028	.048 (15.97)	.046 (14.90)	.044 (13.68)
Non-Md Labor	.172	.161 (-4.42)	.152 (-8.70)	.145 (-11.24)
Md Net Income	.600	.636 (9.68)	.606 (1.67)	.574 (-7.83)
Overall F-Statistic		2422.6	1506.3	181.5

* 1976 Medicare Economic Index cost share for equipment and other overhead expenses. This percentage matches that in the first column.

We will summarize these results by examining the projected differences in specialty-specific price indices which use the historical price ratios. All the test statistics do indicate strong significant differences in cost shares and share indices, but at the same time these differences are small in absolute value. If one assumed that the price ratios in 1977 and 1976 prevailed continuously over the succeeding five years, and if the specialty group cost shares remain unchanged (that is, the Index becomes a fixed-base, non-chained Laspeyres), then the following overall price change will have occurred by the end of the fifth year.

TABLE 14

1976 Share Indices Grouped by Population, Region, and Specialty

	BLS Population Categories				
	Non-SMSA	SMSA			
Region	>50	50-500	500-1000	1000-5000	5000 +
Northeast					
All Internal Med.	1.0514	1.0515	1.0518	1.0525	1.0585
Gen./Family Pract.	1.0540	1.0554	1.0521	1.0621	1.0557
All Surgery	1.0643	1.0662	1.0642	1.0786	1.0972
North Central					
All Internal Med.	1.0583	1.0543	1.0524	1.0568	1.0570
Gen./Family Pract.	1.0611	1.0563	1.0656	1.0621	1.0572
All Surgery	1.0705	1.0723	1.0691	1.0699	1.0782
South					
All Internal Med.	1.0519	1.0509	1.0614	1.0564	
Gen./Family Pract.	1.0562	1.0552	1.0527	1.1127	
All Surgery	1.0601	1.0626	1.0634	1.0732	
West					
All Internal Med.	1.0574	1.0726	1.0549	1.0616	1.0712
Gen./Family Pract.	1.0726	1.0667	1.0633	1.0636	1.0638
All Surgery	1.0754	1.0778	1.0912	1.0825	1.0901

Four-Way Analysis of Variance on 1976 Price Index

Main Effects	Sum of Squares	F-Statistic	Probability Level
SPEC3	.055	96.663	.001
BLSPOP	.013	11.896	.001
REGION	.017	20.607	.001
GROUP	.000	0.267	.605
RESIDUAL	.278		

Specialty Group	1981 (Using 1976 Price Ratios)	1982 (Using 1977 Price Ratios)
Internal Medicine and Specialties	1.318	1.314
General/Family Practice	1.341	1.316
Surgery and Surgical Specialties	1.417	1.327
All Specialties	1.369	1.321

The last line in the above table shows the price increase which would have been allowed all specialties. The difference between the price increase on this line and its constituents above is not great, particularly for the price ratios in 1977 when the price increase from malpractice premiums was less. This table does not deny the presence of significant differences; it only points to the relatively small distortion introduced by keeping one Index versus adopting specialty-specific indices.

A Comparison of Price Index Forms

As indicated above, the Medicare Economic Index has the form of a chained Laspeyres price index. This Laspeyres form appears frequently in government price indices; the BLS consumer price index is a Laspeyres index. However, investigators have considered many alternative forms and have developed criteria to assess their relative advantages. In this final section, we present some of the traditional alternative indices and review some of these criteria. We conclude the section with discussion of the relation between cost functions and price indices and present some translog cost function estimation results.

The forward Laspeyres price index is the ratio of the sum of current prices (p_{1i}), each weighted by base quantities (q_{0i}) to the sum of base prices (p_{0i}), each weighted by base quantities (q_{0i}). The forward Laspeyres index uses the base year as the weighting year, while the backward Laspeyres uses the current year, thus allowing comparisons between the current or weighting year and previous years. Stated another way, the Laspeyres index equals the sum of the ratio of current (p_{1i}) to base price (p_{0i}), each ratio weighted by its own share of base period expenditure:

$$\frac{\Sigma p_{1i} q_{0i}}{\Sigma p_{0i} q_{0i}} = \Sigma \frac{p_{1i}}{p_{0i}} \frac{p_{0i} q_{0i}}{\Sigma p_{0i} q_{0i}}$$

A closely related alternative to the forward Laspeyres is the forward Paasche index, in which the base quantity weights are replaced by current quantity weights:

$$\frac{\Sigma p_{1i} q_{1i}}{\Sigma p_{0i} q_{1i}} = 1 / \left(\Sigma \frac{p_{0i}}{p_{1i}} \frac{p_{1i} q_{1i}}{\Sigma p_{1i} q_{1i}} \right)$$

The Paasche index requires the collection of data for current period weights in each successive period. The Laspeyres index, on the other hand, only requires base period weights. Consequently, constructing a Paasche index entails considerably more effort and the resulting survey costs usually limit its use. Note that neither index requires explicit separation of price and quantity. Knowledge of the expenditure shares alone is sufficient.

The Laspeyres and Paasche indices are only two of the infinitely large class of index number forms. To select a price index from members of this class requires a set of criteria to evaluate both their measurement accuracy and their correspondence to economic assumptions. Irving Fisher (1922) devised two categories of three tests each to assess the measurement accuracy of index numbers. These tests will be reviewed briefly and applied to the Laspeyres index, the Paasche index, and Fisher's ideal index, which is the geometric means of the first two. The Fisher index has the form

$$\left(\left(\frac{\Sigma p_{1i} q_{0i}}{\Sigma p_{0i} q_{0i}} \right) \left(\frac{\Sigma p_{1i} q_{1i}}{\Sigma p_{0i} q_{1i}} \right) \right)^{1/2}$$

Fisher's first category included three simple tests of measurement consistency. The first of these is the identity test which requires that if a situation (a year, for example) is compared to itself, it equals one. The second test is the units test which states that a change in the measurement unit of money will not change the value of the index itself. The third is the homogeneity or proportionality test, which requires that if all prices change by an equal proportion from base to current period, the index itself will change by that proportion. (This test is quite useful, for it is consistent with the property that both demand and factor demand functions are homogeneous of degree zero in both prices.) The Laspeyres, Paasche, and Fisher-ideal index numbers all pass each of these three tests. The demonstrations are straightforward.

The second category of Fisher's tests determines whether an index number is transitive. The first of these tests requires that the forward price (quantity) index equals the inverse of the backward price (quantity) index. In other words, the product of the index measured from current to base and of the index measured from base to current equals one. This test ensures that a change in the reference point of measurement does not change the order of the index number values. Satisfaction of this consistency test would be particularly important if the index were comparing groups; if the test were not satisfied, switching from one reference group to another might not preserve the ordering of the index number values. Among the index forms being considered, only the Fisher ideal index satisfies this test (the component subscripts having been dropped for clarity):

$$\left(\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1} \right)^{1/2} \left(\frac{\Sigma p_0 q_1}{\Sigma p_1 q_1} \frac{\Sigma p_0 q_0}{\Sigma p_1 q_0} \right)^{1/2} = 1$$

However, neither the Laspeyres nor the Paasche index numbers satisfy this test. In the forward Laspeyres case:

$$\left(\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0}\right)\left(\frac{\Sigma p_0 q_1}{\Sigma p_1 q_1}\right) \gtrless 1$$

(that is, not necessarily equal) because the inverse of the forward Laspeyres is the backward, not the forward, Paasche. The latter appears as the second term above.

The second test in this category requires a transitivity across components. In the case of a price index measured across time, this test specifies that the index measured from the base to the current period equals the product of the same index measured from the base to an intermediate period and from the intermediate period to the current period. None of the indices being considered satisfies this test. In the Laspeyres case:

$$\left(\frac{\Sigma p_t q_0}{\Sigma p_0 q_0}\right) > \left(\frac{\Sigma p_k q_0}{\Sigma p_0 q_0}\right)\left(\frac{\Sigma p_t q_k}{\Sigma p_k q_k}\right)$$

With a Laspeyres index form and given a price increase which produces substitution toward the less expensive item, the left hand side of the equation exceeds the right. While the right side includes the effect of substitution and base change during an interim (k) period, the left does not. The right side is a fixed-base Laspeyres while the left is a single-step chained Laspeyres. The Medical Economic Index is a chained Laspeyres but with the base weights changing annually. As the revisions to the base weights become more frequent, the chained Laspeyres more closely approximates the continuous Divisia index. The Divisia index is the only weighted index which satisfies this test. Consequently, because of its chained forms, the Medicare Index will nearly satisfy this test.

This condition imposes a fairly restrictive test. The importance of the test arises in the estimation of price changes when the base period has changed during the interim. Ignoring that base change will upwardly bias the Laspeyres index number (assuming substitution toward the less expensive items). An index satisfying this test would not require use of the changed base to approximate the impact of substitution, but a fixed base index such as the Laspeyres index does require using the changed interim period weights.

The final Fisher test requires that the product of the price and quantity indices equals the change in total expenditure. Neither the Laspeyres nor the Paasche indices satisfy this test. In the case of the Laspeyres:

$$\left(\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0}\right)\left(\frac{\Sigma p_0 q_1}{\Sigma p_0 q_0}\right) \gtrless \frac{\Sigma p_1 q_1}{\Sigma p_0 q_0}$$

However, the Fisher ideal index does.

$$\left(\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \cdot \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1}\right)^{1/2} \left(\frac{\Sigma p_0 q_1}{\Sigma p_0 q_0} \quad \frac{\Sigma p_1 q_1}{\Sigma p_1 q_0}\right)^{1/2} = \frac{\Sigma p_1 q_1}{\Sigma p_0 q_0}$$

This test is often referred to as the factor reversal test; note that the test requires that the total expenditure change is explained as the product of the price and quantity indices. This consistent separation of price and quantity changes can have useful applications if one is interested in isolating the price change component.

Other indices satisfy these tests. Stuvel (1957) suggested a formulation using only the forward Laspeyres price and quantity indices. His deriviation started with a separation of the change in total value ($\Sigma p_{i1}q_{i1} - \Sigma p_{i0}q_{i0}$) into price and quantity changes. In this derivation, Stuvel averaged prices in the quantity difference equation and averaged quantities in the price equation. This is the essence of the difference between the Fisher ideal index and the Stuvel index, although Stuvel did not highlight it. Whereas Stuvel weighs each price difference ($p_1 - p_0$) by its own average quantity ($q_1 + q_0/2$), Fisher weighs each price ratio (p_1/p_0) by the product of its base (current) expenditure share and the total Paasche (Laspeyres) price change. Thus, the Fisher ideal index weighs the individual price ratios by the product of own expenditure shares and the change in overall prices. The Stuvel index separates price and quantity changes explicitly (denoted I_P and I_Q, respectively, below):

$$I_Q = \frac{L_Q - L_P}{2} + \left(\left(\frac{L_Q - L_P}{2}\right)^2 + \frac{\Sigma p_{i1} q_{i1}}{\Sigma p_{i0} \Sigma q_{i0}}\right)^{1/2}$$

$$I_P = \frac{L_P - L_Q}{2} + \left(\left(\frac{L_P - L_Q}{2}\right)^2 + \frac{\Sigma p_{i1} q_{i1}}{\Sigma p_{i0} \Sigma q_{i0}}\right)^{1/2}$$

where L_Q is the Laspeyres quantity index and L_P the price index. I_P is the total effect of all price changes, and I_Q is the total effect of all quantity changes. Stuvel showed that his indices satisfied all the tests which Fisher's ideal index satisfied; in particular note that $I_Q I_P = (\Sigma p_1 q_1)/((\Sigma p_0 q_0)$. However, note that Stuvel's index does require explicit separation of price and quantity in subsequent years, which is sometimes difficult.

The preceding analysis applies several measurement tests to select among indices. The remainder of this section evaluates the economic implications of some indices. The basic Task I objective is the development of a price index for physician firms. If a particular cost function applies to these firms, the price index should reflect the structure of the cost function. Unfortunately, only a small portion of the literature on price indices analyzes the correspondence between cost functions and price indices. Two exceptions are Vartia (1976) and Diewert (1976, 1978).

A basic observation about the Laspeyres index is in order before considering the work of Diewert. In the Laspeyres index, the total price change equals the ratio of the sum of the products of base quantities and current prices to the sum of the products of base quantities and base prices. The use of base quantities as weights in the current period implies that no substitution occurs in production as a result of the price changes. This implication points to a very restrictive assumption about the nature of the underlying production function, namely that (at least in the short-run, between the base and current periods) the elasticity of substitution between inputs is zero because the production function is characterized by fixed factor coefficients.

On the other hand, comparing current prices and quantities to base quantities and current prices, the Paasche index asks the hypothetical question: what would have been the values of production at base prices given the current mix of quantities? The Paasche index assumes that complete substitution among quantities has occurred. Consequently, the Fisher index, which is the product of the Laspeyres and Paasche, brackets the substitution possibilities. If no substitution occurs, then the Fisher index reduces to the Laspeyres and with complete *ex post* substitution to the Paasche.

Diewert developed the link between cost functions and the Vartia and Tõrnquist indices. Diewert's development is rather technical and only some results will be described. He defined a general criterion for the equivalence of the price index, as well as the ratio of the cost function evaluated at current prices to the cost function evaluated at base prices. This criterion stated that the cost function is exact for a price index if, given the base and current price vectors, the dual linearly homogeneous aggregator (that is, 'production') function has a maximum which corresponds to the input base and current quantity vectors respectively.

Diewert then demonstrated that the Vartia index is exact for the Cobb-Douglas unit cost function. The Vartia index is defined as

$$\ln P_v = \sum \frac{(p_{1i} q_{1i} - p_{0i} q_{0i}) / (\ln (p_{1i} q_{1i}) - \ln (p_{0i} q_{0i}))}{(\Sigma p_{1i} q_{1i} - \Sigma p_{0i} q_{0i}) / (\ln (\Sigma p_{1i} q_{1i}) - \ln (\Sigma p_{0i} q_{0i}))} \times \ln \frac{p_{1i}}{p_{0i}}$$

and the Cobb-Douglas unit cost function is defined as

$$\ln c = \alpha_0 + \Sigma \alpha_i \ln p_i$$

where c is cost per unit, α_0 a constant, p_i the input prices, and $\ln P_V = \ln c_1 - \ln c_0$. The Vartia quantity index only substitutes the ratio of quantities in the cost term. The product of the Vartia price and quantity indices equals the change in total cost. In other words, the Vartia indices satisfy the Fisher factor reversal test. Furthermore, if the firm's technology corresponds to a linearly homogenous Cobb-Douglas production function (that is, the elasticity of substitution equal to one), then the use of the Vartia index ensures that the price ratios are weighted by factors consistent with the underlying technology. With Cobb-Douglas technology, use of the Laspeyres index would over-report the price change, while use of the Paasche index would under-report it.

Diewert goes on to show that the Tõrnquist index is exact for the translog unit cost function. This result is quite interesting because the translog function is much more flexible than the Cobb-Douglas, allowing non-constant elasticities of substitution. (As Theil noted in 1973, the index is not unique to Tõrnquist and is frequently used as the discrete approximation to the Divisia index.) The Tõrnquist price index is

$$\Sigma \tfrac{1}{2} \left((p_{i0}\, q_{i0} / \Sigma\, p_{i0}\, q_{i0}) + (p_{i1}\, q_{i1} / \Sigma\, p_{i1}\, q_{i1}) \right) \left(\ln (p_{i1}) - \ln (p_{i0}) \right)$$

The first two ratios are the expenditure shares in the base and current period, respectively. The translog unit cost function corresponding to a linearly homogeneous translog production function is

$$\ln c = b_0 + \Sigma b_i \ln p_i + \tfrac{1}{2} \Sigma\Sigma b_{ij} \ln p_i\, p_j$$

where c is cost per unit and p_i the input prices. The price index equals the difference between unit cost function evaluated at current prices and at base prices or, if this price index is designated as $\ln P_T$, $\ln P_T = \ln C_1 - \ln C_0$, where C_1 is evaluated at current prices and C_o at base prices. The quantity index substitutes quantities for prices in the price ratio terms above, but the expentiture shares are identical. The quantity index equals the ratio of the aggregator function evaluated at current quantities to the aggregator function evaluated at base prices.

The product of the price and quantity indices does not quite equal the change in total cost but, as Theil showed, approximates it to the third order of smallness. This means that the Tõrnquist index does not quite satisfy the Fisher factor-reversal test. If the firm's technology corresponds to a linearly homogenous translog production function, then use of this index will insure that price ratios are weighted by factors consistent with the underlying technology. The translog function allows a very flexible specification for the technology and includes the Cobb-Douglas as a special case ($\sigma = 1$).

Diewert demonstrated the exact correspondence between the Tŏrnquist index and the translog function under constant returns to scale. Diewert (1976) also showed that when the translog does not exhibit constant returns, the Tŏrnquist index does not correspond uniquely to the translog but to a wider class of functions, including the translog. In this general form of the translog, output enters not as y_0 in the base and y_1 in the current period but as $(y_0 y_1)^{1/2}$ in both. (Diewert demonstrated this result for the more general non-homothetic case, in which the "cross-effect" of input price with output enters the cost function.)

Note that the index has two other rather minor limitations. First, if a quantity is present in some periods but not others, the log operator in the quantity index will be undefined in years in which this quantity is absent. This problem does not exist in the price index. Secondly, unlike the Laspeyres, Paasche, and Vartia, this index is not quite consistent in aggregation: combining subindices will not exactly yield the overall index.

The index has a major non-technical limitation. It requires the estimation of base and current expenditure shares because the weights are averages of the two periods. Continual sampling to determine current expenditure shares entails considerable re-survey expense; as indicated above, the Paasche index encounters the same problem. Of course, use of the information from the last and current period avoids the "drifting" problem which occurs when only a Laspeyres index is used; the standard resolution for the problem is the chaining (that is, multiplying) of up-dated Laspeyres indices together. Chaining the Tornquist indices would improve this solution.

Diewert's work suggests a way to avoid some of the costs of re-surveying. If the underlying technology remains constant, the estimated coefficients of the translog unit cost function can predict the Tŏrnquist index. The predicted index would equal the ratio of the product of the estimated coefficients $\hat{\beta}$ and the current price vector P_1 over the products of the coefficients and the base price vector P_0. For this reason, we will estimate cost function parameters; the discussion concerning that estimation is in the next section. Without the same re-sampling which this procedure seeks to avoid, one could not be confident that the underlying technology had not changed and that the estimated coefficients used in the ratio's numerator were correct. However, one might be somewhat confident that a substantial shift would not occur within, for example, five years, which is the usual period for changing the base in the use of the Laspeyres indices. However, if the possibilities for substitution among inputs in physician firms are not considerable, then the correspondence between the flexible translog and the Tornquist index may not be that important. Note that if such substitution were very low or slow to occur, then use of a Laspeyres type index would not misrepresent critical cost shares.

Several problems arise in the estimation of cost functions for physicians. If the firm does not minimize costs, the estimated parameters of any given cost function will not represent the possibilities for substitution under conditions of efficient production. This outcome makes interpretation of the estimated parameters difficult. Note that if the producer in a non-competitive industry is a cost-minimizer, identifying the parameters of the firm in the non-competitive case may still be a problem because equilibrium price and quantity will be a function of both supply and demand. Another way to view this problem is that the system is not identified by estimation of the cost function alone. A further problem is the endogeneity of the price of the physician's own labor; to interpret the estimated parameters as determining elasticities of substitution requires that the the prices be exogeneous to the firm. Similarly, output should be exogenous. In the case of physician firms, neither output nor price of physician labor is likely to be exogenous; in fact, they are probably jointly determined.

As a mathematical function, a cost function can assume a variety of forms. Two commonly used forms are the Cobb-Douglas and the translog. Each corresponds to different assumptions about the possibilities for substitution among factor inputs. Their differences, however, extend beyond this because the translog allows non-homotheticity and a greater flexibility in the form of non-constant returns to scale. The Cobb-Douglas form implies that the Allen partial elasticities of substitution between pairs of inputs (σ_{ij}) are constant and equal to one, while the translog form imposes no restrictions: the elasticities can assume any real value and can vary with the level of the cost shares and the relationship between a cost share and other input prices. Although the translog and not the Cobb-Douglas was estimated, the latter is reviewed below to show the impact of one important problem: the unavailability of price data in the survey.

The Cobb-Douglas production function has the form:

$$\ln Y = k + \Sigma \alpha_i \ln X_i$$

where Y is output and the X_i the set of inputs. Cost minimization subject to this production function (and through a series of substitutions) yields a total cost function, the estimated form of which is

$$\ln (C - P_j) = \alpha + \Sigma \alpha_i \alpha_y \ln(P_i - P_j) + \alpha_y \ln Y$$

where C is total cost, each P_i is the price of the input, each α_i is from the production function, and α_Y is the inverse of the sum of the α_i. If the sum of the α_i is less (greater) than one, decreasing (increasing) returns to scale are present. The product $\alpha_i\alpha_Y$ equals the cost share of the ith input (p_iX_i/C). In order that the estimated parameters of all cost shares sum to one, $\Sigma p_iX_i/C = 1$, the estimation of the cost function must incorporate the equivalent restriction $\alpha_i\alpha_Y = 1$, which is implemented by subtraction of any one price from the total cost and all other prices.

Information on one or more prices may not be available; for example, the Survey does not have price data on office materials, equipment or floorspace, or medical materials or equipment. If these prices were correctly assumed to be constant across firms, their effect would enter the estimated constant term. But since several prices are missing, their estimated cost shares would only be known in the aggregate as $1 - \Sigma\, \alpha_i\alpha_Y$, where $\Sigma\, \alpha_i\alpha_Y$ covers only those inputs with non-missing price data. In fact, the only prices available are the wage rates for labor. Thus, even if the unavailable prices were constant across firms, no separate cost shares could be inferred. (The Cobb-Douglas function has a redeeming feature here; its assumption of strong separability in inputs (all $\sigma_{ij} = 1$) is equivalent to the existence of a consistent aggregate subindex of prices. Therefore, if one price could be found which would describe the entire set of missing prices, no information would be lost. Unfortunately, however, no such price index is in the Survey or conveniently recommends itself.) Because the missing prices are non-labor, one might be tempted to treat them all as "capital" and use the price of external financing as a proxy, but this use confuses the real and the financial sides of the firm's operation. For example, if two firms faced the same price vector of inputs but different prices for external financing because of imperfect capital markets, their choice of input might well differ, but not because of different possibilities for substitution in production.

The translog cost function has the form

$$\ln C = a_0 + a_Y \ln Y + \tfrac{1}{2}\, g_{YY} (\ln Y)^2 + \Sigma_i\, a_i \ln P_i + \tfrac{1}{2}\, \Sigma_i \Sigma_j\, g_{ij} \ln P_i P_j + \Sigma_i \Sigma_j\, g_{Yi} \ln Y \ln P_i$$

where C is total cost, Y output, and P_i the input prices. For the translog function to have the desirable characteristic of homogeneity of degree one in prices, which implies that a uniform increase in all prices results in a proportionate increase in total costs, the following restrictions must hold:

$$\Sigma_i\, a_i = 1\ ;\ \Sigma_i\, g_{Yi} = 0;\ \Sigma_i\, g_{ij} = \Sigma_j\, g_{ij} = \Sigma_i \Sigma_j\, g_{ij} = 0$$

These restrictions constrain the cost share sum to equal one (Christiansen and Greene, 1976).

Differentiating the cost function with respect to prices yields a set of cost share equations of the form

$$S_i = a_i + g_{Yi}\, Y + \Sigma_j\, g_{ij} \ln P_j$$

where the S_i are the cost shares of the ith input. Because of the probable substantial multicollinearity among all the price and cross-price variables in the cost function, estimation of the cost share equations yields considerably more precise parameters. However, the cost share equations do not include several parameters appearing in the cost function itself. Their absence prevents testing hypotheses of homotheticity and homogeneity which respectively imply $g_{Yi} = 0$ and $g_{Yi} = g_{YY} = 0$. If these hold, and if all the $g_{ij} = 0$, the translog reduces to the Cobb-Douglas form. Joint estimation of the cost function and the cost share equations allows the testing of these hypotheses. Because the cost shares must sum to one, one cost share equation must be dropped from this system. Parameter estimates which are invariant to the equation being dropped require iterated estimation of the system: the Zellner procedure is one approach (Christensen and Greene, 1976).

We estimated the translog cost function using two sets of prices. The Survey itself includes prices only for the malpractice premium and for non-physician employees. Table 15 displays the estimated coefficients and elasticities of substitution for a translog in which the weighted average price of non-physician employee labor acted as a proxy for all costs except malpractice and physician net income. (Undoubtedly this simplification creates serious problems; however, the alternative method of imputing prices, which is reported in Table 16, has its own problems.)

The physician wage was not imputed by a regression of employee net income per hour on employees and area characteristics, as investigators often do to address the problem of the endogeneity of physician net income. A regression using the 1976 Survey data explained relatively little of the variation in employee net income per hour. In fact, none of the coefficients was statistically significant at accepted confidence levels. Thus, we could not use this approach to eliminate the potential correlation of net income per hour with the error term.

However, we did use a procedure which addresses a related part of the problem. We estimated physician net income per hour as a function of own characteristics such as age, type of group practice, and board certification status. The wage imputed by this process does not represent a market-determined wage, given the opportunities for the doctor outside the firm. This predicted wage still includes the measure of rent accruing to physicians generally. Inclusion of rents in this predicted wage implies that we are not estimating the true parameters of the cost function. But it does exclude from the firm-by-firm variation in the physician wage that part unrelated to physician characteristics. This predicted wage may more closely represent the physician's perceived long run opportunity cost of time.

The translog cost function in Table 15 also includes a measure of output, office visits, to determine if the hypotheses of homotheticity or homogeneity are satisfied. (We recognize that physicians do not treat office visits exogeneously, and the resulting endogeneity does again create the potential for bias in parameter estimates.) It *appears* that homotheticity is not satisfied given the pattern of significance in the G_{Yi} terms, but a complete test requires estimation of the translog under the restrictions of homotheticity ($G_{Yi} = 0$) and use of the likelihood ratio test. Because of the preliminary nature of these estimated functions, we did not do this. The proper test of homogeneity also requires a separate estimate with restrictions, but we also did not complete this, partly because the variable office visits does not fully capture the impact of scale economies. In Table 15, examination of the estimated elasticities of substitution between factors indicates that physician time, malpractice insurance, and other expenses (for which employee wage is the proxy) are usually competitive as inputs ($\sigma > 0$) except for allergists. In many instances the G_{ij}'s are insignificant ($\sigma = 1$).

Table 15 presents the estimated parameters of specialty-specific cost functions assuming that the parameters differed significantly among specialties. We tested the hypothesis that the parameters were, in fact, not significantly different among the internal medicine specialties (allergy, cardiovascular disease, dermatology, and gastroenterology). To complete this test, we used an analysis of covariance. The value of this F-statistic was .596, which is less than the tabulated value of $F_{12,164}$ at the 5 percent level of significance, 1.88. We also completed an analysis of covariance for the surgical specialties (neurological surgery, orthopedics, otolaryngology, ophthalmology, and urology). This test produced an F-statistic of 3.08 which suggests that we can reject the hypothesis of homogeneity among the surgical specialties. Further aggregation of surgical specialties would be inappropriate. Finally, we tested for homogeneity among internists and internal medicine specialists as a group. This test produced an F-statistic of 13.71, which points to differences between internal medicine and its specialties. These results indicate that aggregation of internal medicine specialties may be appropriate, but aggregation of surgical specialties is not.

Table 16 uses imputed prices from the BLS Metropolitan Area Survey of Family Budgets. Physicians in the same SMSA received the mortgage share of the intermediate family budget as a proxy for the price of rent and their medical expenditures as a proxy for other costs. This imputation rests on several very strong assumptions: that the changes in the budget share primarily reflect responses to changes in price and that the residential price changes parallel rental price changes for physician office space. This imputation is neither conceptually nor empirically very successful, but few alternative price series are available from published sources.

In Table 16, the following subscripts indicate associated inputs: 1, physician input; 2, employee; 3, malpractice; 4, other; 5, rent. Few of the total Physician Practice Cost Survey cases matched the BLS area survey data which reduced the sample size and meant that separate estimation by individual specialty was not feasible. We omitted output and only estimated the share equations (less one). As Table 16 shows, few of the elasticities of substitution are significantly different from zero. This lack of significance reflects, among other things, the relatively small variation in the BLS budget shares for the matched cases.

The results of the translog cost estimation suggest that in the absence of more accurate prices, this approach will not produce results sufficiently reliable for the Medicare Economic Index. Future work would examine the more restricted translog form in Table 15 to determine the impact of substitution in the estimation of Index price changes. Allowing for the possibility of substitution among inputs because of price changes is the primary advantage in using a cost function approach, rather than other price or variable-based indices. However, input price variations facing the physician firm may not lead to significant substitution effects in the short run. If this is the case, using a fixed-base index will not result in serious bias.

TABLE 15

Translog Cost Functions by Specialty
(t-statistics in parentheses)

	Allergy	Cardio-vascular	Derma-tology	Gastroen-terology	General Practice	General Surgery	Internal Medicine	Neurolog. Surgery	Ophtha-mology	Ortho-pedic Surgery	Otolaryn-gology	Urology
A_0	6.8122	2.1867	5.7186	4.4194	9.3910	9.7659	10.2263	8.8403	9.6128	9.2640	9.4161	9.3145
	(2.25)	(0.58)	(3.62)	(1.38)	(13.52)	(13.69)	(9.07)	(6.43)	(7.81)	(6.27)	(7.31)	(6.20)
A_1	0.1299	0.1725	0.6252	0.2484	0.7626	0.7005	0.6442	0.9963	1.0652	0.9620	1.0634	0.9595
	(0.71)	(0.75)	(5.39)	(1.27)	(14.69)	(12.71)	(9.40)	(8.71)	(10.11)	(8.68)	(9.83)	(8.65)
A_1	0.8877	0.9182	0.3789	0.7817	0.1918	0.2569	0.3211	-0.0274	-0.0988	-0.0002	-0.0966	0.0022
	(4.83)	(3.99)	(3.13)	(3.97)	(3.67)	(4.61)	(4.61)	(-0.26)	(-0.99)	(-0.002)	(-0.95)	(0.02)
A_3	-0.0177	-0.0906	-0.0043	-0.0301	0.0455	0.0426	0.0347	0.0311	0.0336	0.0382	0.0333	0.0382
	(-0.59)	(-2.21)	(-0.16)	(-0.96)	(3.51)	(3.01)	(1.89)	(1.08)	(1.42)	(1.26)	(1.35)	(1.24)
A_Y	1.1671	2.8634	1.5137	2.0875	-0.0393	-0.2264	-0.4864	-0.2119	-0.6413	-0.4030	-0.5207	-0.4186
	(0.94)	(1.94)	(2.10)	(1.59)	(-0.13)	(-0.70)	(-0.98)	(-0.31)	(-1.05)	(-0.55)	(-0.82)	(-0.56)
G_{YY}	-0.0298	-1.0419	-0.5490	-0.7750	0.0655	0.1674	0.2971	0.2081	0.4661	0.3018	0.4062	0.3079
	(-0.82)	(-1.76)	(-1.67)	(-1.44)	(0.46)	(1.14)	(1.34)	(0.61)	(1.54)	(0.83)	(1.29)	(0.83)
G_{Y1}	0.0235	0.0231	-0.0385	0.0133	-0.0331	-0.0327	-0.0244	-0.0319	-0.0569	-0.0301	-0.0568	-0.0308
	(0.64)	(0.50)	(-1.53)	(0.34)	(-3.00)	(-2.72)	(-1.66)	(-1.14)	(-2.23)	(-1.11)	(-2.16)	(-1.13)
G_{Y2}	-0.0341	-0.4694	.0320	-0.0269	0.0357	0.0344	0.0243	0.0374	0.0594	0.0359	0.0596	0.0366
	(-9.23)	(-1.03)	(1.22)	(-0.68)	(3.21)	(2.84)	(1.62)	(1.46)	(2.45)	(1.46)	(2.39)	(1.48)
G_{Y3}	0.0105	0.0239	0.0065	0.1360	-0.0026	-0.0017	0.0001	-0.0055	-0.0024	-0.0058	-0.0028	-0.0057
	(1.74)	(3.04)	(1.21)	(2.13)	(-0.99)	(-0.60)	(0.03)	(-0.79)	(-0.43)	(-0.79)	(-0.47)	(-0.77)
G_{11}	0.1281	0.0920	0.0403	0.0895	-0.0089	0.0159	0.0241	-0.0441	-0.0490	-0.0395	-0.0502	-0.0394
	(5.80)	(3.98)	(2.09)	(3.60)	(-0.98)	(1.46)	(2.18)	(-4.17)	(-4.38)	(-3.79)	(-4.39)	(-3.77)
G_{22}	0.1219	0.0896	0.0385	0.0847	-0.0083	0.0147	0.0228	-0.0369	-0.0472	-0.0332	-0.0477	-0.0332
	(5.47)	(3.58)	(1.98)	(3.381)	(-0.90)	(1.35)	(2.05)	(-3.55)	(-4.24)	(-3.24)	(-4.18)	(-3.23)
G_{33}	0.0006	0.0000	0.0005	0.0008	0.0009	0.0009	0.0010	0.0006	0.0011	0.0008	0.0010	0.0009
	(1.64)	(0.08)	(1.49)	(1.84)	(4.59)	(4.18)	(4.22)	(1.07)	(2.36)	(1.55)	(1.98)	(1.55)
G_{12}	-0.1247	-0.0880	-0.0391	-0.8675	0.0091	-0.0149	-0.0230	0.0408	0.0486	0.0368	0.0494	0.0367
	(-5.63)	(-3.79)	(-2.03)	(-3.48)	(0.99)	(-1.37)	(-2.08)	(3.92)	(4.39)	(3.59)	(4.36)	(3.58)

TABLE 15 (Continued)

	Allergy	Cardio-vascular	Derma-tology	Gastroen-terology	General Practice	General Surgery	Internal Medicine	Neurolog. Surgery	Ophtha-mology	Ortho-pedic Surgery	Otolaryn-gology	Urology
G_{13}	-0.0034	-0.0040	-0.0012	-0.0028	-0.0002	-0.0010	-0.0012	0.0033	0.0004	0.0027	0.0007	0.0027
	(-2.41)	(-2.26)	(-0.89)	(-1.82)	(-0.23)	(-1.35)	(-1.45)	(2.11)	(0.25)	(1.74)	(0.49)	(1.70)
G_{23}	0.0028	0.0040	0.0006	0.0020	-0.0007	0.0001	0.0002	-0.0039	-0.0015	-0.0036	-0.0017	-0.0035
	(1.89)	(2.12)	(0.44)	(1.26)	(-1.00)	(0.18)	(0.24)	(-2.65)	(-1.08)	(-2.49)	(-1.20)	(2.45)
n	42	27	58	37	172	150	125	49	70	51	65	50
Log of Likelihood Function:												
	63.511	34.973	64.518	56.180	222.262	190.371	160.600	55.337	83.613	58.745	72.795	55.909
Elasticities of Substitution Between Factors												
σ_{12}	0.4706	0.6206	0.8326	0.6342	1.0000*	1.0000*	0.8995	1.2073	1.2472	1.1870	1.2498	1.1867
σ_{13}	-1.3305	0.7573	0.9196	0.8174	0.8619	1.0000*	1.0000*	1.0695	1.0000*	1.0578	1.0000*	1.0561
σ_{23}	3.0206	1.2311	1.0424	1.1341	1.1171	1.0000*	1.0000*	0.8629	1.0000*	0.8709	1.0000*	0.8742

1=Physicians
2=Other
3=Malpractice

*Not significantly different from 1.0 at the 0.1 level

TABLE 16
Translog Cost Function Coefficients
for Internal Medicine and Surgery
Homogeneity and Homotheticity Assumed
(t-statistics in parentheses)

	Internal Medicine and Specialties		Surgery and Specialties	
	Solo	Group	Solo	Group
A_1	0.2589	0.3052	0.3591	0.3976
	(8.51)	(6.57)	(13.40)	(11.67)
A_2	0.1901	0.2365	0.2286	0.2845
	(7.93)	(5.42)	(10.84)	(11.18)
A_3	0.0812	0.0520	0.1090	0.1011
	(9.09)	(4.22)	(16.59)	(12.75)
A_4	0.1839	0.2839	0.1485	0.1445
	(4.11)	(6.37)	(5.51)	(4.43)
A_5	0.2859	0.1224	0.1547	0.0723
	(6.41)	(2.80)	(5.17)	(2.21)
G_{11}	0.1696	0.1120	0.1658	0.1447
	(9.95)	(5.49)	(10.78)	(6.98)
G_{12}	-0.0063	-0.0047	-0.0662	-0.0760
	(-0.51)	(-0.27)	(-5.93)	(-5.27)
G_{13}	-0.0025	-0.0024	-0.0012	-0.0014
	(-2.65)	(-1.38)	(-1.45)	(-1.22)
G_{14}	-0.0770	-0.0476	-0.0659	-0.0567
	(-8.73)	(-4.88)	(-10.49)	(-6.60)
G_{15}	-0.0838	-0.0574	-0.0326	-0.0106
	(-10.94)	(-7.82)	(-4.28)	(-1.62)
G_{22}	0.0185	0.0178	0.0453	0.0598
	(1.52)	(0.99)	(3.48)	(4.05)
G_{23}	-0.0003	0.0013	-0.0001	0.0003
	(0.45)	(0.76)	(-0.22)	(0.31)
G_{24}	0.0012	-0.0024	0.0171	0.0007
	(0.15)	(-0.27)	(2.32)	(0.07)
G_{25}	-0.0138	-0.0121	0.0038	0.0161
	(-1.70)	(-1.60)	(0.39)	(1.70)
G_{33}	0.0022	0.0008	0.0018	0.0017
	(5.77)	(1.60)	(3.87)	(2.74)
G_{34}	0.0002	0.0005	-0.0004	0.0000
	(0.35)	(0.76)	(-1.39)	(0.07)
G_{35}	-0.0002	-0.0003	0.0001	-0.0006
	(-0.42)	(0.56)	(0.21)	(-1.68)
G_{44}	0.0869	-0.0103	0.0574	0.0574
	(3.05)	(-0.36)	(3.10)	(2.42)

(continued)

TABLE 16 (Continued)

	Internal Medicine and Specialties		Surgery and Specialties	
	Solo	Group	Solo	Group
G_{45}	-0.0113	0.0597	-0.0083	-0.0014
	(-0.43)	(2.29)	(-0.49)	(-0.07)
G_{55}	0.1090	0.0100	0.0371	-0.0035
	(4.07)	(0.38)	(1.95)	(-0.16)
n	108	40	116	57
Log of Likelihood Function:				
	564.82	240.26	717.26	399.43

Elasticity of Substitution Between Factors

	Internal Medicine and Specialties		Surgery and Specialties	
	Solo	Group	Solo	Group
σ_{12}	0.9386	1.0000*	0.2208	0.1786
σ_{13}	0.8686	1.0000*	1.0000*	1.0000*
σ_{14}	0.0644	0.3931	-0.0727	0.0138
σ_{15}	-0.9007	-0.3611	0.0004	1.0000*
σ_{23}	1.0000*	1.0000*	1.0000*	1.0000*
σ_{24}	1.0000*	1.0000*	2.1253	1.0000*
σ_{25}	0.0923	1.0000*	1.0000*	2.6616
σ_{34}	1.0000*	1.0000*	1.0000*	1.0000*
σ_{35}	1.0000*	1.0000*	1.0000*	0.8920
σ_{45}	1.0000*	6.0563	1.0000*	1.0000*

* Not sigificantly different from 1.0 at the 0.1 level.

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Hospital Characteristics, Physician Productivity, and Fee Levels

by Mark V. Pauly

This paper examines the effect of hospital inputs on physicians outputs and prices. The primary measure of hospital inputs was the ratio of hospital employees per active staff physician in the surveyed physicians' primary affiliated hospital.

The paper reports that increases in the number of hospital employees per staff physician leads to substantial increases in physician output. Increasing this ratio from one standard deviation below the mean to one standard deviation above the mean results in an increase in value weighted output (sum of visits and operations weighted by relative prices) for GPs of 8.7 percent, for internists and general surgeons of 20 percent, and for orthopedic and neurosurgeons of 40 percent.

The author additionally analyzes the effect of hospital inputs on physician charges. Based upon reduced-form equations, he finds that increases in area-wide hospital inputs have a negative effect on charges for all specialties, but one that is sometimes statistically insignificant.

The paper's conclusions question the equity of the Medicare Economic Index. Differences in the rate of growth in hospital inputs per physician will lead to changes in physician real income, if all physicians are subject to the same Index level. The author also suggests that rapid increases in future physician supply will be associated with both increased competition for staff appointments and declining physician productivity.

Introduction and Model

Purpose of the Study

Physicians on average spend about one-third of their working time at the hospital. There are many activities, especially diagnostic ones, which can be performed either in physician offices or in hospitals. Insofar as patients pay part of the bill, a high hospital charge can affect what the physician is able to get for his or her own services. These observations, as well as many others that could be made, suggest that the resources and services at hospitals and the costs hospitals incur for those services may affect physician productivity and prices. In particular, it is likely that hospital "inputs"—defined in the broadest sense to include productive factors hired by the hospital, hospital facilities, and hospital services—affect physician behavior.

This paper reports on an analysis of a data set constructed by linking individual physicians' practice inputs, costs, and fee levels with information on hospital inputs and charges or costs at the hospital those physicians use. This analysis indicates that such hospital inputs and characteristics affect physician productivity and fee levels. An implication is that such effects should be reflected in physician incomes as well.

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In what follows, I first present a brief discussion of the basic conceptual model of the interaction between physician practices and hospital inputs. In this model, as distinct from some of my other work with Michael Redisch (1973), the behavior of the hospital itself and its response to physician preferences is not explicitly modeled. Instead, the level of hospital inputs and costs is taken as given by the individual physician. The consequences of altering this assumption will be discussed briefly. After presenting the conceptual model and discussing the data set, I provide a more informal treatment of the effects of hospital inputs on physician productivity. Discussion of the construction of variables precedes a presentation of results of estimation of production functions and price functions. The paper closes with a brief discussion of policy implications.

Conceptual Model of Physician Practice

The physician is assumed to face a demand curve which depends on the price paid for his or her services, the price paid to the hospital, and other parameters of the demand in the community:[1]

$$(1\text{-}1) \quad Q_D^i = Q_1 (P_M, P_H, X,)$$

where Q_D^i is a vector of services demanded from physician i, P_M is a vector of *user* prices for physicians' services, P_H is a vector of user prices for hospital services, and X is a vector of other demand parameters. In the case of an insurance which provides uniform coinsurance, an element of P_M or P_H would be NINS $\cdot\ \hat{P}$, where $\hat{P}$ is the gross price charged and NINS is the fraction not covered by insurance. Other kinds of insurance policies imply different specifications. (The information actually collected in the survey on insurance coverage will not in any case permit precise measurement of NINS.)

The relationship between P_H and the elements of Q_D^i depends on whether the physician service in question is a *substitute* or *complement* to hospital outputs. For example, physicians' hospital visits to inpatients are complementary to hospital admissions. Some kinds of physician office visits, on the other hand, may substitute for hospital admissions or procedures. However, the broad class of "office visits" will also include substantial numbers of visits that are complementary to hospital outpatient visits and which can, if the patient's condition warrants, be advantageously combined with hospital outputs in the course of treatment. I will return to this issue below.

The physician is constrained by a production function which relates his or her own time input, other purchased inputs, and hospital inputs and characteristics to the amount of output produced:

$$(1\text{-}2) \quad Q = Q_2 (M, L, H, Z)$$

where Q is a vector of outputs, M is a vector of physician time input, L is a vector of non-physician inputs hired by the physicians, H is a vector of hospital inputs, measured either by actual inputs (for example, FTE personnel and beds) or by intermediate outputs (for example, services and facilities), and Z is a vector of practice characteristics. Some hospital characteristics, such as its teaching status or its control, may also measure some aspect of input levels or production function form.

Other inputs L are assumed to be available at a uniform price per unit C_L. For simplicity, it is assumed that the physician firm behaves as if physician input is available at a constant cost C_M. Finally, it is also assumed for simplicity that each physician uses only one hospital.

The hospital is assumed to set its price to cover its total cost:

$$(1\text{-}3) \quad \Sigma_i \hat{P}_H^i Q^i = C_H \cdot H$$

where $\hat{P}_H^i$ is the gross *hospital* charge for physician i's output Q^i (with those elements of $\hat{P}_H^i$ being zero for the outputs for which hospitals are not used), and C_H is a vector of prices for hospital inputs.

Physician pricing depends upon the degree of competition. If the physician has monopoly power, he or she will select the levels of M, L, and $\hat{P}_M^i$ (given the demand curve, the production function, and the price of inputs) which maximize net income:

$$Y^i = \hat{P}_M^i \ \Sigma_i \ Q_i - C_L L - C_M M.$$

The reduced form equation for optimal price then becomes

$$(1\text{-}5) \quad \hat{P}_M^i = P(NINS^i, X^i, H^i, C_M^i, C_L^i, C_H^i, Z^i)$$

where the i's represent the levels of each variable in the physician's practice or in the hospital he or she uses.

If the presence of hospital inputs affects marginal cost (as well as total cost), as seems most plausible, physician price will be affected by H^i. If, however, the market for physicians' services is approximately competitive, then $\hat{P}_M$ will be given as far as the individual physician is concerned. It will, therefore, not depend upon the physician's own values of C_M or H. For example, just because a physician is able to obtain aide time cheaply or has secured an appointment at a well-equipped hospital is no reason for him or her to charge a lower price. For the market as a whole, of course, the going price will depend on market-wide levels of the demand and supply parameters. That is, the price charged by the competitive physician will depend upon market-wide levels of the variables in Equation (1-5).

[1]See Technical Note B for listing of variables.

Some simple geometry will indicate what this model implies about the effect of hospital inputs on physician productivity and prices. Consider the case in which hospital and physician outputs are highly complementary and in fixed proportions. Then the demand curve for any one of a set of identical physicians can be written as a function of the sum of the user prices, or $Q_D=Q(P_M+P_H)=Q(P_T)$. Given some fixed level of insurance coverage which is less than full coverage, demand can also be written as a function of gross prices $Q_D=(\hat{P}_M+\hat{P}_H)=Q(\hat{P}_T)$. Given some level of hospital inputs and prices, the level of $\hat{P}_H$ is determined and is proportional to hospital inputs per unit of output at any quantity. At any quantity, the price the physician will be able to charge will be $\hat{P}_T-\hat{P}_H$.

Such a situation is shown in Figure 1. Demand per physician is drawn as a function of $\hat{P}_T$. It is reasonable to suppose that the physician takes the break-even hospital price $\overline{P}_H$ as given, independent of his or her own output. (If all physicians were to change their output, the complementary hospital output, $\overline{P}_H$, would change, since the cost of a given amount of H per physician would be spread over a different amount of output. But it is plausible that each physician assumes that other physician output is given.) The demand curve facing the representative physician is therefore the part of $D(\hat{P}_T)$ above $\overline{P}_H$, shown in Figure 2 as $D_O(P_M)$. The curve MC_O shows the physician's marginal cost curve, including the cost of his or her own time.[2] Its position depends on the form of the production function, the level of input prices C_M and C_L, and the stock of hospital inputs H available to the physician. Given the MR curve as shown, the physician's income-maximizing price will be $\hat{P}_{MO}$.

Now suppose the level of hospital inputs is increased at Q_O (and at all other outputs). Given Q, the level of hospital inputs available to the physician will increase. This will have two effects. First, from the production function, it will tend to reduce the physician's marginal cost at any output. The new level is represented in Figure 2 by MC_1. Second, it will cause $\overline{P}_H$ to increase because the hospital will have to raise its rates (under less than full insurance) to cover the costs of the new inputs. The precise position of the new equilibrium depends on how Q changes, but it is likely that $\overline{P}_H$ will rise to a level such as $\overline{P}_{H1}$. The new equilibrium price then will be at $\hat{P}_{M1}$, less than $\hat{P}_{MO}$. Note that $\hat{P}_M$ will have fallen for two reasons: (1) MC was reduced, and (2) $\overline{P}_H$ was increased. Since Q could also have increased, net physician income could have either risen or fallen. If, on the other hand, H had stayed constant at any Q, but C_H had risen, then only $\hat{P}_H$ would have shifted up. Physician price would still fall, but physician productivity would be unaffected.

[2]In principle, all of the information contained in the production function *plus* additional information on input prices is contained in the cost function. The Physicians' Practice Costs Survey (PPCS) in fact collected data on some physician office costs, and cost functions were estimated as part of our project.

If some physician outputs and hospital outputs were substitutes rather than complements in demand, then the effect on price would be ambiguous. Increasing H would still lower MC, but it would then increase rather than reduce the demand for those physician outputs. Price could rise, fall, or stay the same.

From this analysis we obtain the following two propositions, which will be subject to empirical tests in what follows:

(1) Hospital inputs and characteristics will be related to physician productivity.

(2) Hospital inputs will affect physician price. The most likely effect is that higher levels of inputs will result in a lower level of physician prices.

So far I have focused on the effect of hospital inputs on individual physician practices, assuming that each physician takes the level of those inputs as given. Such an assumption may not be plausible for two reasons. First, physicians can "shop" for a hospital to which they will seek a staff appointment. Indeed, many believe that competition for physicians is the primary way in which hospitals compete. If physicians sort themselves among hospitals in ways which are related to their ability or need for the hospital's inputs, this should be taken into account. Second, physicians may have considerable control over the hospital's choice of inputs. If medical staffs are homogeneous, the hospital inputs available to a physician may be as much a consequence of his or her own characteristics and actions as a determinant of those actions. This would simply make hospital inputs endogeneous, like other physician-hired inputs, and their level would be determined in the same way as any other input.

If hospital inputs are endogenous, then physician incomes would be wholly explained by input prices (including hospital input prices) and by demand variables. The fact that some demand variables are not measured could still produce a statistical relationship between hospital input quantities and physician income, but this would only be because hospital inputs were proxying the underlying demand variables. Unfortunately, the price function estimates in this paper will not deal with this kind of endogeneity.

Previous Work

The relationship between hospital inputs and characteristics and aspects of the physician's practice has not been investigated very extensively. The few studies which have been made have used aggregated data and have not related individual physician behavior to the particular hospital used for most patients.

FIGURE 1

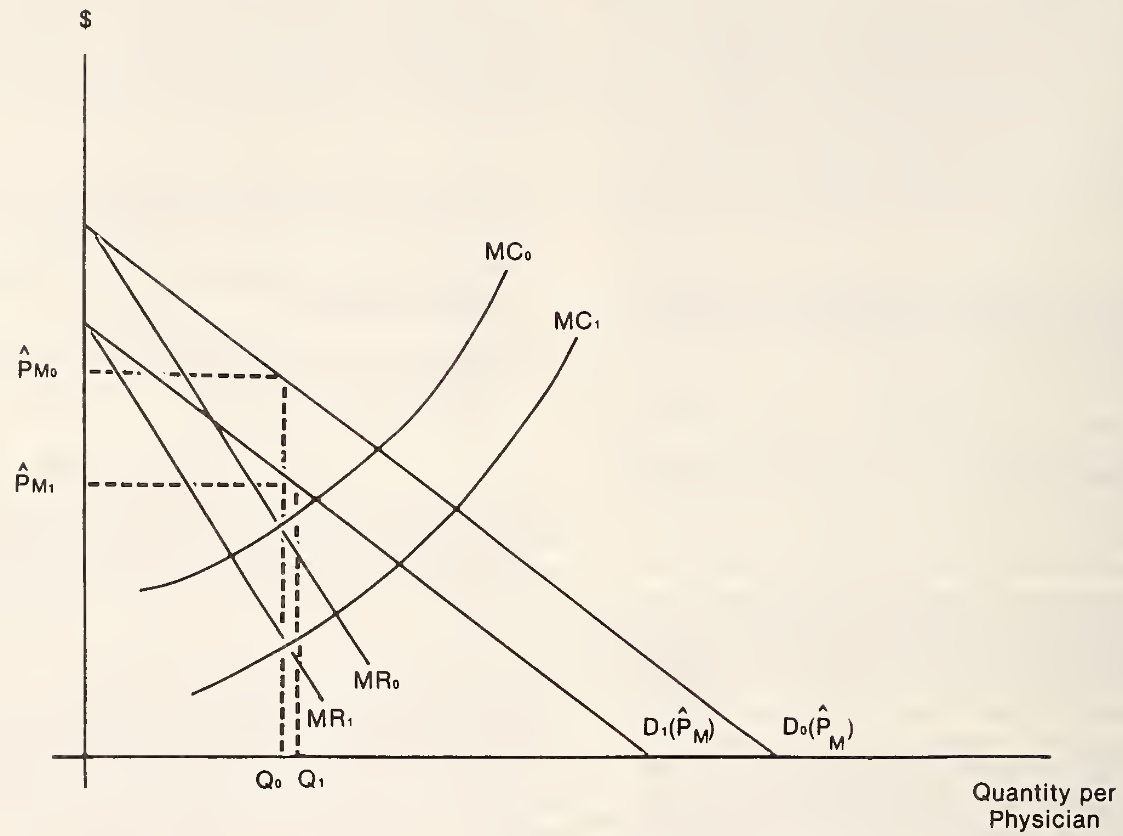
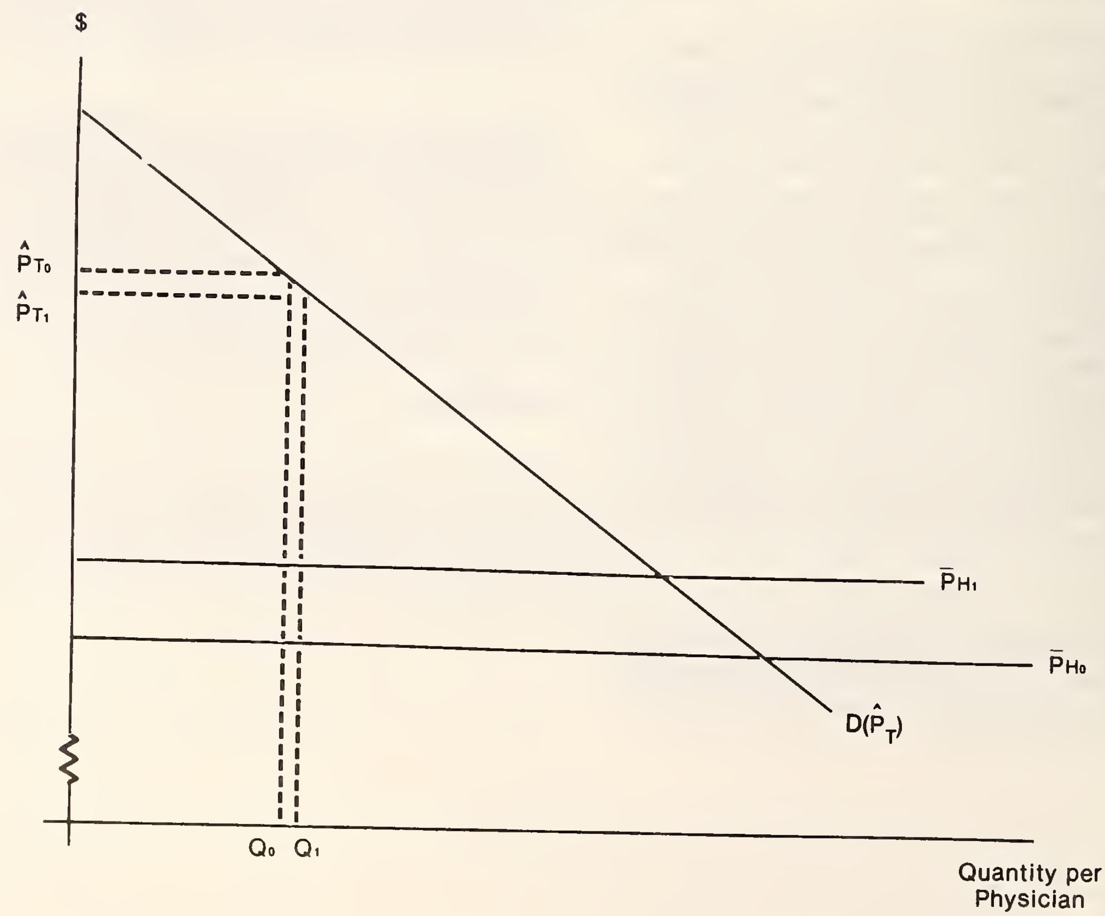


FIGURE 2



Redisch *et al* (1981), using the 1975 Physician Practice Cost Survey data, related hospital beds *per capita* in the SMSA to a set of physician variables in reduced form equations. They found that primary care physicians' productivity, costs, and fees were not significantly related to hospital beds, while there was a significant but small (elasticity = 0.1) relationship between hospital beds and primary physician net income. For surgical specialists the relationships were much stronger. Beds were related positively to output and negatively to costs and prices. Since these are reduced form results, it is difficult to give precise interpretation to these coefficients, but they do seem to be consistent with the theory outlined here.

Gaffney (1979) looked at the relationship between average practice costs per office patient visit and a measure of the scope of facilities and services available at all hospitals in the county. He selected only those physicians in counties with five or fewer hospitals. Apparently all office costs were attributed to office visits. The scope measure was the fraction of a list of 20 facilities and services available at the hospitals in the county. Gaffney found a significant negative relationship between number of facilities and cost per patient visit. He did not, however, hold constant the level of actual hospital inputs *per physician*, nor did he have information on the level of inputs or facilities at the hospital the physician actually used.

Other than these two studies, there does not appear to be any attempt to investigate the relationship between hospital inputs and physician behavior. Results of the two studies are, however, broadly consistent with the predictions of the theory just outlined.

Assembly and Editing of Data

The data set combined information from three major sources: (1) The 1976 PPCS; (2) hospital data from the American Hospital Association Annual Survey (AHAAS); and (3) information on the number of physicians with hospital staff appointments, taken from HCFA's Provider of Services data (POS).

In the 1976 PPCS, the hospital identification for each physician was provided by the answer to survey question 38: "To which hospital do you primarily admit patients?"

In answer to this question, 178 of the 3,482 physicians in the sample reported "no hospital" (coded zero), which is a legitimate or usable answer. Most of those physicians who did not use a hospital were psychiatrists.

The hospital codes for the remaining 3,304 physicians were compared with the list of hospital codes for the 1976 AHA annual survey. Of this number, only 162 physicians were unable to be matched with hospitals which reported data to the AHA survey.

Finally, physicians were matched with data on numbers of medical staff members at their hospitals in the Provider of Services file. The POS data are furnished by each Medicare-certified hospital as part of the recertification process. In total, 40 additional physicians had appointments in hospitals which did not provide POS data. A total of 5.8 percent of initial observations were therefore lost because of inability to match with reporting hospitals. The percentage lost is small for all specialty groups, ranging from 0.1 percent of allergists to 8.7 percent of GPs. In total, then, less than 10 percent of physician observations were lost for any specialty. (Individual data items are, of course, likely to be missing with various degrees of frequency.) It appears that the matching process has been quite successful, that the number of lost observations is sufficiently small for analysis to proceed, and that no appreciable bias could be introduced by the small number of lost observations.

Production Functions

Introduction

A production function relates outputs produced to inputs used. It represents the maximum outputs that can be produced with various sets of inputs. Production functions have been estimated for physicians' services (Reinhardt 1975; Held and Reinhardt 1979), but typically they have concentrated on outputs produced in the physician's office and have wholly ignored the presence or absence of hospital inputs and hospital characteristics. As discussed in the preceding sections, it is the estimation of precisely these relationships which is the major concern of this project.

In this section I will first present an informal discussion of the ways in which hospital inputs might affect physician productivity—the behavior which underlies the statistical results to be presented. Next, I will discuss problems concerned with the measurement of outputs and inputs and then turn to the issue of functional forms for the production function. Finally, the empirical results will be presented and discussed.

Effects of Hospital Inputs on Physician Productivity

Physicians typically spend a good deal of their time at the hospital, and (with variation by specialty) much of the output which they produce and for which they collect revenue is directly produced at the hospital. Visits to inpatients, in-hospital surgical procedures, and patients seen in the hospital emergency room or clinics are all "outputs" of the physician, at least as output is typically measured. It seems plausible to suppose that the amount and type of hospital inputs available to the physician may affect the outputs he or she can produce, and the amount of his or her own time devoted to the production of that output.

In part, the hospital inputs may serve as substitutes for the physician's own inputs. For example, physician time per unit of output may be reduced if skilled nurses or residents are available. The effect of such a substitution will be a higher observed output for given physician time input. Some hospital inputs may be complements, in the sense that they enhance the productivity of the physician's time. An intensive care unit or a CAT scanner may permit a given physician to care for more patients with a given amount of his or her own time. Indeed, for some types of output, the complementary relationship may be so strong that, without some type of equipment or facility, it is impossible to produce an output at all. In principle, this should only lead to different output mix. In the value aggregation measures of output I will be using, however, it may in fact show up as lower total "output."

So it is reasonable to expect that the productivity of the time the physician spends at the hospital (and hence of total working time) may be enhanced by the presence of hospital inputs. What of productivity in the office? Here the inputs that the physician hires directly, such as nurses' time, other aides' time, and supplies would probably be related to output measured by office patient visits. The hospital's inputs and characteristics, however, can affect office productivity. The most obvious effect involves case-mix or severity mix. If the physician's hospital is poorly equipped, or if he or she must share a limited amount of hospital inputs with a large number of other physicians, it is likely that (other things equal) the doctor will treat patients requiring more complex procedures in the office. It is likely that he or she will equip and staff the office to compensate for the absence of facilities at the hospital. While I included measures of the additional office equipment and personnel directly in the production function, I did not measure office case-mix or case complexity directly. Empirically, one would observe a positive relationship between office visit output and hospital inputs, given the levels of office inputs. That is, physicians who use hospitals with fewer inputs per physician will tend to have fewer office patient visits. Finally, whatever the case-mix, it is possible that the physician with easy access to hospital inputs may do more of the workup and testing of patients in the hospital setting (especially for those hospitalized anyway, for example, surgical patients). Performance of part of the work at the hospital may then permit the doctor to deal more expeditiously with those patients when they are seen in the office.

For these reasons, it seems desirable to estimate three kinds of production functions. In one, I will use a measure of "total output," and estimate the effect of hospital inputs and characteristics on total productivity, given the levels of all other inputs and certain characteristics of the physician, the practice, or both, which might be related to productivity.

In the second, in what might be called a "separate specification" (not, however, according to the technical definition of separable), I will explore the effect of hospital inputs on the relationship between a particular type of output (for example, office patient visits, hospital visits, or operations) and the physician time devoted specifically to the production of that output. In effect, I will assume that physician time used in production of one output has effects which are separate from those on the production process for other outputs.

In the third specification, I will consider in a multiproduct specification the relationship between one relatively homogeneous output (again, office visits or operations, for example), total practice inputs, and *all other* inputs and outputs. However, a complete investigation of all possible interactions between input and output types is not feasible, given the number of interactions that would have to be investigated in a complete specification.

Aggregated Output

The basic data in the survey provide a comprehensive tabulation of physician outputs, grouped into roughly homogeneous groups. Patient visits at an exhaustive set of locations (office, home, hospital, inpatient, clinic, nursing home, and other) are tabulated, as are total operations.[3]

The total output measure computed and used in the empirical work was a "value-weighted" total output. This measure is a weighted sum of patient visits and operations, with the weights representing relative prices or values of outputs. Relative price weights are computed separately for each specialty. Office visits are assigned a weight of unity. The weight attached to hospital visits for each specialty is then given by the ratio of the specialty mean hospital visit fee, as estimated from the data set, to the specialty mean office visit fee. Home visits and nursing home visits are given a value of two office visits, the weight assigned by the California Relative Value (CRV) Scale. Emergency room and clinic visits were assigned a value of unity. For those specialties for which a fee for surgical procedure was given in the data, an "office visit equivalent" weight per operation was computed in the following way. First, the mean fee for the surgical procedure was divided by the number of CRV units in the procedure to get a mean fee per CRV unit. (For example, for general surgeons the mean fee for an inguinal herniorraphy was divided by the number of CRV units for the procedure.) The SOSSUS study (1975) gives estimates of the mean number of CRV units per operation for most surgical specialties. Multiplying the mean number of CRV units per operation by fee per CRV unit yields an estimate of the fee per "average" operation. Finally, dividing the fee per operation by the office visit fee gives an office visit equivalent per operation. For specialties for which no surgical procedure fee was given, the weight for general surgeons' perfor-

[3]A crude measure of gross revenues is also available, but, even after deflation, this measure did not yield reasonable production function coefficients.

mance of an inguinal herniorraphy was used. (This technique may slightly overstate the office visit equivalent of operations, since in the data a physician was credited with an operation for assisting as well as for serving as the primary surgeon.)[4]

Disaggregated Output Measures

The most theoretically satisfying way of estimating production relationships (but probably the most difficult to interpret) is to permit the different types of output to enter the production function in a disaggregated fashion. To do this, I define the following different outputs for the data:

a) Office-related visits (OFFVIS): office visits plus 2 times (home visits plus nursing home visits)

b) Hospital-related visits (HOSVIS): visits to inpatients plus patients seen in hospital clinics or emergency rooms

c) Operations (OPERNS).

When more than one specialty is combined in a subsample, the SOSSUS average CRV per operation values are used to convert total operations to an equivalent value. Functional forms suitable for incorporating all outputs into the production function are discussed below.

Omission of Outputs

While these measures were constructed with some care, there may still be some problems in getting accurate measures of output, and hence of productivity. It is possible, first of all, that there are differences in the quality or characteristics of output across physicians which could be correlated with hospital input measures: a routine follow-up office visit may include more from a physician at one kind of hospital than from another physician at another kind of hospital. (Measurement error in the dependent variable which is uncorrelated with the explanatory variables will, of course, not lead to biased estimates.) There may also be types of outputs (various diagnostic procedures, for example) which are not counted at all. I include some locational variables to try to control in part for differences in quality or style of visits across areas, but these variables are quite crude and are subject to alternative interpretations, as will be discussed below. Finally, there is one output "produced" by the hospital and physician inputs in combination which is not measured at all in the data: the hospital admission. For surgical specialists, for whom the bulk of admissions are associated with an operation, this omission may not be serious, since the number of operations counts the number of admissions. For medical specialists, the omission in the data of a measure of total inpatient admissions treated by the physician means that we cannot measure the total output. It also means that the tests of efficient resource combinations, described in our analytic plan, may not be very conclusive, especially if they show an overuse of hospital inputs.

Measures of Practice Inputs

Physician Time

The most important input into the production of the physician's output is his or her own time. Accordingly, physician time (MDHRS), either in total or as assigned to various activities, is included as one of the inputs.

Aide Hours

The physician typically employs aides in his or her office practice. I distinguish between the time input of medical aides (NURSHRS) and that of non-medical employees (OTEMPHR). A term for the square of the sum of all employee hours (EMHRSQ) is included to permit diminishing marginal product.

Supplies

The total amount spent for medical supplies is also included as an input (SUPPLIES). Somewhat surprisingly, a significant number of owner-physicians reported zero expenditures for supplies. (These were true zeroes, not missing values.) Since literally zero expenditure seems implausible, and since supplies seem to be an essential input, I assigned a $50 yearly cost for supplies to these physicians.

Number of Physicians

For solo practitioners, the total amount of office inputs should be attributed to the physician being sampled. For multi-physician practices, the figures for employee hours and supplies expense need to be somehow allocated among physicians. Since no direct measure exist in the data, we are forced to divide such inputs by the number of full-time equivalent physicians associated with the practice. (Physicians working more than 20 hours a week were called full-time, and part-time physicians were arbitrarily counted as half a full-time physician.)

Measures of practice size (GROUPSIZE) were also included directly in the production function. If all firms had equal technical efficiency, then the coefficients on these measures would indicate economies or diseconomies of size. (Both GROUPSIZE and its square, SIZESQ, are included, to permit effects to change direction.) However, there is reason to believe that the incentives to technical efficiency may vary with practice size (Held and Reinhardt, 1979). Since we have no direct measures of the incentives for efficiency provided by compensation schemes, and since perfect measures are not feasible anyway, the measured effect of practice size may include some of these incentive effects.

[4]Extreme value editing discarded observations in which total visits exceeded 550 for the sample week or operations exceeded 50. This editing reduced the total sample size by 10 physicians. In addition, physicians specializing in psychiatry were not included in the data set analyzed.

Measures of Physician Characteristics

The productivity of the physician's time may vary with certain aspects of training or experience.

Specialty

Physicians of different specialties provide different services. They also may provide the same services in different ways. To account for the possibility that these differences would effect the entire production function, I have generally estimated different production functions for different specialties. Such a procedure permits the effects of all of the *independent variable* regressors (not just the constant term) to be different for different specialties. To achieve a larger sample size, specialties are occasionally combined, in which case a dummy variable for specialty type is included (SDUM).

Board Certification

A dummy variable indicating whether the physician is board-certified (BCDUM) is included in the regression.

Experience

Since productivity may vary with the physician's experience, variables measuring the number of years since medical school graduation (YRGRAD) and its square are included.

Measures of Hospital Inputs and Characteristics

Hospital Inputs

The most critical element of the theory described above is that hospital input availability may affect physician productivity. The total number of full-time-equivalent hospital personnel and the number of hospital beds (a possible measure of capital) are present in the AHA data. To convert these measures to a per-physician basis, each was divided by the number of physicians on the active medical staff of each hospital, as reported in the Provider of Services file. Personnel per active staff physician and beds per physician turned out to be highly positively correlated, with a simple r of about 0.94. Moreover, although each variable was usually significant when included alone in preliminary regressions, addition of the other variable made both insignificant with coefficients of opposite sign. These results strongly suggest collinearity, so the variable "beds per physician" was deleted in the results to be presented, and only results using a measure of the number of hospital employees per staff physician (HEMP/SMD) are included. The number of interns and residents per staff physician (IR/SMD) is also included, although its predicted effect on productivity is ambiguous. On the one hand, such physicians in training probably provide the closest substitute for the time of the practicing physician. On the other hand, a part of the practicing physician's time (not specifically identified in the survey) may be diverted from patient care to informal teaching. In addition, students may consume hospital personnel inputs and other inputs for teaching purposes, leaving actually fewer to enhance the productivity of staff physicians.

Hospital Size and Scope

Hospital bed size (HOSSIZE) is included in the analysis to account for possible diseconomies of size in effects on physician productivity. With a given allocation of inputs, the physician in the larger hospital may find that his or her time is used either more or less efficiently than in a smaller hospital. Another measure of hospital characteristics is the presence or absence of specialized facilities and approved services. Such a concept is conveniently summarized by Trivedi's weighted index (1978). It happened, however, that these two measures were also highly correlated in my data

$$(r = 0.9),$$

and neither was significant when both were entered together in preliminary regressions. Accordingly, the measure of facilities and services was deleted, and only hospital size was included in the regressions. This means that the effect of the hospital size variable summarizes both the effect of size *per se* and of the presence of specialized facilities.

Hospital Control

The ability of the physician to apply hospital inputs in ways which enhance his or her own productivity may be related to the control of the hospital. For example, the ability of the physician to divert hospital inputs to enhancing personal productivity may be less in a government-owned hospital than in a non-profit hospital. Or the physician productivity of government-controlled hospitals may simply differ. PUBLIC indicates a dummy variable for a government-controlled hospital. It would have been interesting to examine the relationship between proprietary hospital inputs and physician productivity, but the number of physicians in the sample with appointments at such hospitals was too small (less than 5 percent) to provide an accurate estimate.

Staff Appointments per Physician

If physicians in an area typically hold staff appointments at more than one hospital, inputs per staff physician may not accurately measure the amount of inputs per FTE physician. For example, consider two towns with identical numbers of physicians; each town has two identical hospitals. In one town, physicians are equally divided between the two hospitals, and have appointments at only one of them. In the other town, all physicians have appointments at each hospital. The measure of hospital inputs per physician will be twice as high in the first town as in the second, and yet there is no difference in access to inputs.

To control for these influences, I calculated a measure of number of staff appointments per patient care physician (APPOINTS) for all of the market areas used in the sample. In each rural county or SMSA, I calculated the total number of active staff appointments and divided it by the American Medical Association's estimate of the number of patient care physicians. Such a measure in effect controls for multiple appointments, although only at the market area level, not at the level of the physicians using a particular hospital.

Area Characteristics

In principle, the production function which describes the technical relationship between inputs and outputs should not vary with characteristics of the region being served. However, I also included two measures of area characteristics in the production function: the number of patient care physicians *per capita* (MDPOP) and a dummy variable for urban location (URBAN). The effects of these variables could be interpreted in several ways. First, and most appropriately, the characteristics of areas may proxy the style or type of output. Second, including these characteristics confronts the issue of whether some of the hospital variables described above might be proxying those characteristics. A less legitimate interpretation, however, would be the interpretation that the variables proxy per physician *demand.* If there is some excess capacity, these variables may offset, or at least diminish, the importance of legitimate input or production function variables.

For example, suppose board-certified surgeons tend to receive a larger share of the patient pool in any market, and suppose full-time surgeons generally need to devote some given minimum number of hours to their practice. Then "productivity" will be higher for board-certified surgeons, but this finding will not mean that maximum feasible output per hour is affected by board certification. Accordingly, in presenting the results I will also comment briefly on the consequences of deleting these two variables.

Functional Forms

The general notion of a production function is that it relates inputs and outputs. We assume in general that the function is *separable in outputs*, and so can be written:

$$G(Q) = F(X)$$

where Q is a vector or measure of outputs and X is a vector of inputs, hospital, area, and physician characteristics. Consider each side of the equation in turn:

Input Side

The general form I use for inputs might be termed the "Reinhardt Transcendental" (RT), which has been successfully used in other estimates of physician production functions (Held and Reinhardt, 1979; Reinhardt 1975). It takes the general form:

$$(2\text{-}1)\quad Q = M^{\alpha_1} S^{\alpha_2} H^{\alpha_3} e^{\beta_1 L_1 1 + B_2 L_2 + \beta_3 (\Sigma L)^2 + \Sigma \gamma_i Z_i}$$

where M is MD hours, S is supplies, H is hospital inputs (personnel or beds) per active staff member, L_1 and L_2 are the hours of two types of physician office labor, and X is a vector of other independent variables.

This function exhibits the appropriate neoclassical properties. It is more suitable than either a Cobb-Douglas or translog form, both of which require that all inputs always be positive for output to be positive. While the assumption of positive inputs is plausible for physician time and (I have argued) supplies, and while I have deleted physicians with no hospital affiliation from the sample, it is obviously possible for the physician to produce output with no aide time or with no interns and residents in the hospital.

Output Side

When output can be represented by a single number, as with the value weighted sum measure described below, the specification (2-1) provides a full representation of the production function. Logarithms then yield the following estimating equation:

$$(2\text{-}2)\quad \ln Q = \text{CONST} + \alpha_1 \ln M + \alpha_2 \ln S + \alpha_3 \ln H + \beta_1 \text{ NURSHRS} + \beta_2 \text{ OTEMPHR} + \beta_3 (\Sigma \text{MDHRS})^2 + \Sigma_i \gamma_i X_i$$

where Q is the value-weighted sum.

When the "separable" process specification is used, output is measured by total office visits, total hospital visits, or total operations. The input side takes the same form as that just described, except that the physician time variable is the time *associated* with that output (for example, physician time in the office seeing patients).

When an explicit multiple output specification is used, however, a specific functional form for the output function must also be chosen. Some common and convenient functions are not, however, legitimate. The profit-maximizing multiple output firm should exhibit a transformation curve between outputs which is concave to the origin. A linear specification is obviously very restrictive, and a Cobb-Douglas (linear in logs) specification implies a *convex* transformation curve. While it is easy to imagine output functions which permit concave transformation functions, they usually yield estimating equations which are nonlinear and inconvenient.

A reasonably convenient form which can be estimated with a linear function is one suggested by Mundlak (1964). It has the general output function (for n outputs)

$$(3\text{-}3)\quad G(Q) = \prod_{i=1}^{n} (Q_i^{\alpha_i} e^{\sum_{i=1}^{m} \beta_i Q_i})$$

If all $\beta_i = 0$, then this is a Cobb-Douglas function, but a concave transformation curve requires that $B_i > \alpha_i / Q_i$. Mundlak suggests normalizing on one output, assuming that all the β_i are equal, and weighting outputs by their prices. Logarithms then yield the estimating equation:

$$(3\text{-}4)\quad \ln Q_1 = \text{CONST} + \sum_{i=2}^{n} \alpha_i \ln Q_i + \beta_i \sum_{i=1}^{n} P_i Q_i + F(X)$$

where F(X) represents the input side.

In my application, this specification obviously requires that all three outputs—office visits, hospital visits, and operations—be positive. While this is the case for some specialties (GS and OBG, for example), and while virtually all physicians in some other specialties produce two and only two outputs (for example, IM and PEDS), in general practice and medical specialties, a sizeable fraction of physicians produce no hospital visits and/or operations. In these cases I do not present results. The term summing all outputs is represented by VWOTPT.

Results

Value-Weighted Output

I first present results in which output is measured by the value-weighted sum. Because the main interest in this project was on the effects of hospitals on physician productivity, I shall primarily discuss the coefficients on hospital variables. However, I shall comment on the other variables when they are of interest. Means and standard deviations of variables are shown in Appendix Table A1. Results are shown in Table 1.

The most consistent and important result is that the measure of hospital inputs available to the physician (LHEMP/SMD) is almost always significantly related to the physician's output, holding constant his or her time and practice inputs. (The letter L indicates natural logarithm of a variable.) Moreover, the coefficients usually suggest rather large quantitative effects. Raising HEMP/SMD from one standard deviation below the mean to one standard deviation above the mean would, as shown in the last line of the table, increase GP output by 8.6 percent, internist output by 20.1 percent, general surgeon output by 19.2 percent, and orthopod or neurosurgeon output by 40.2 percent.

Other hospital variables are significant less frequently. Hospital size (which also proxies the presence of specialized facilities) has a significant effect on productivity only for GS and OBG, and the effect is negative. Perhaps this result means that diseconomies of scale and problems of coordination within the hospital tend to offset any productivity gains from the presence of specialized hospital facilities, or perhaps it implies that the outputs—patient visits and operations—tend to be more complex for such physicians, so that less of them are produced with given inputs. In any case, it implies that there is no direct relationship between customary measures of physician output and hospital size, facilities, or sophistication.

A variable measuring hospital personnel per bed is also included, but is significant and negatively related to output only for internists. With personnel per physician included in the regression, higher values of personnel per bed imply lower values of beds per physician. So a reasonable interpretation is that, for internists, productivity is related both to the availability of hospital personnel *and* hospital beds.

Whether a hospital is governmentally owned or not is unrelated to productivity except for internists, allergists, and other medical specialists, where the relationship is negative, and general surgeons, where the relationship is positive. The availability of interns and residents enhances productivity for obstetricians, reduces it for neurosurgeons and orthopods, and leaves it unaffected for all other specialties. Finally, the number of hospital appointments per physician in the area appears to be unrelated to physician productivity.

Similar results are obtained when we look at physicians in three specialties—GP, IM, and OBG—who reported that they worked regular hours in the survey week. The measures of output and physician time input are taken from a question that asks the physician about his or her experiences in the week prior to the survey, while the office inputs are measured as averages over an entire year. Since non-physician inputs, including hospital employees per staff physician, are probably not varied extensively even when the physician takes some time off, the observations using regular hours may give a more accurate measure of the "permanent" production function. As shown in Table 1, these observations do yield somewhat lower estimates for the coefficients on physician hours, and somewhat higher coefficients for hospital personnel per staff physician. For obstetricians in particular, the effect of hospital inputs on outputs is much stronger for those who reported that they worked regular hours.

MDPOP and URBAN generally had little effect on the results. Both of them were insignificant in all but the GP and general surgeon regressions. For GPs, deletion of these variables increased the coefficient on LHEMP/SMD to .11 (significance level, 0.10) and reduced the coefficient for general surgeons to .14 (significance level, 0.10).

Separate Production Processes

Next I present results of regressions in which the process of producing each type of output is conceived as a "separate" one. That is, it is assumed that office-related physician services are produced with office inputs and physician time spent in the office, while hospital-related physician services are produced with physician time spent in the hospital seeing patients or performing operations, respectively. The amount of physician time devoted to production of one output is assumed *not* to affect the production of other outputs. Since some non-physician office inputs are used in connection with hospital-oriented services (billing for hospital visits, for example), and since there is no way to separate office employee hours and supplies into "office-visit-related" and "hospital-visit-related" uses, I will use total non-physician office inputs in all functions. One would intuitively suppose that hospital inputs and characteristics should be most strongly related to the production of hospital-related outputs—hospital visits and surgery. We will, however, test for the possibility that hospital inputs affect the physician's *office* productivity.

TABLE 1

Regression of Physician Output on Physician Time and Characteristics, Practice Inputs, and Hospital Inputs and Characteristics By Specialty (Owner-Physicians Only) Dependent Variable: LN of Price-Weighted Sum of Outpatient Visits, Inpatient Visits, and Operations. (Significance Levels in Parentheses)

Specialty	GP (All)	GP (Reg. Hrs.)	IM (All)	IM (Reg. Hrs.)	PEDS	Primary Care Solo	GS	OBG (All)	OBG (Reg. Hrs.)	NEUR-ORTH.	OEU	ADCG
LNMDHRS	.904	.711	.739	.775	.904	.951	1.12	1.09	1.01	.818	.930	.815
	(.000)	(.000)	(.000)	(.000)	(0)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
GROUPSIZE	-.026	-.084	.032	.110	.023	—	.045	.160	.170	.318	.091	.075
	(.74)	(.37)	(.70)	(.29)	(.28)	—	(.59)	(.09)	(.12)	(.002)	(.38)	(.44)
SIZESQ	.004	.014	-.004	-.015	—	—	-.002	-.019	-.024	-.026	.002	-.004
	(.68)	(.28)	(.73)	(.29)	—	—	(.86)	(.14)	(.09)	(.08)	(.92)	(.74)
NURSHRS	.010	.009	.006	.007	.007	.008	.003	.005	.003	.009	.003	.001
	(.000)	(.000)	(.001)	(.001)	(.000)	(.000)	(.12)	(.004)	(.26)	(.78)	(.09)	(.51)
OTEMPHR	.009	.007	.003	.004	.008	.006	—	.003	.003	.001	.003	.002
	(.000)	(.000)	(.06)	(.02)	(.000)	(.000)	—	(.02)	(.04)	(.55)	(.09)	(.15)
EMHRSQ	-.000002	-.00002	-.000007	-.00001	-.00002	-.00001	-.0000004	-.000004	-.000002	-.000003	-.000004	-.000001
	(.000)	(.001)	(.10)	(.02)	(.000)	(.000)	(.94)	(.007)	(.31)	(.68)	(.30)	(.77)
LNSUPPLIES	.046	.048	.025	.026	-.003	.028	.020	.012	.029	.017	.034	-.002
	(.006)	(.007)	(.19)	(.21)	(.84)	(.04)	(.31)	(.58)	(.27)	(.49)	(.08)	(.91)
LNHOSSIZE	.047	.040	.020	.005	-.011	.054	-.141	-.128	-.218	.029	-.078	.0009
	(.39)	(.49)	(.80)	(.96)	(.87)	(.22)	(.08)	(.16)	(.04)	(.78)	(.31)	(.99)
LNHEMP/SMD	.076	.148	.167	.187	.133	.149	.183	.106	.211	.393	.280	.028
	(.30)	(.07)	(.07)	(.06)	(.11)	(.01)	(.05)	(.30)	(.06)	(.001)	(.001)	(.76)
IR/SMD	.220	.180	-.046	-.057	.052	-.083	.019	.163	.540	-.096	.247	.013
	(.54)	(.59)	(.79)	(.75)	(.71)	(.54)	(.96)	(.51)	(.10)	(.06)	(.38)	(.79)
YRGRAD	—	-.007	.014	.020	-.006	.003	-.026	-.008	.022	-.023	-.011	.007
	—	(.44)	(.14)	(.12)	(.44)	(.63)	(.04)	(.55)	(.26)	(.000)	(.29)	(.49)
YRGRADSQ	-.00006	.00001	-.0002	-.0004	.00008	-.0001	.0003	-.00005	-.0006	—	.00007	-.00006
	(.15)	(.91)	(.10)	(.18)	(.50)	(.28)	(.14)	(.80)	(.06)	—	(.65)	(.71)
BCDUM	-.038	-.015	-.020	.032	.56	-.006	.203	-.050	-.244	.197	.062	-.091
	(.70)	(.88)	(.81)	(.74)	(.04)	(.92)	(.02)	(.62)	(.06)	(.06)	(.47)	(.30)
PUBLIC	-.056	-.072	-.213	-.276	—	-.179	.259	-.078	-.093	.075	.161	-.221
	(.51)	(.43)	(.09)	(.05)	—	(.02)	(.04)	(.55)	(.55)	(.60)	(.14)	(.09)
APPOINTS	.011	.009	-.004	-.006	-.001	.012	-.045	.003	.0007	.005	-.002	.006
	(.29)	(.33)	(.62)	(.45)	(.83)	(.25)	(.50)	(.76)	(.94)	(.56)	(.85)	(.47)

(continued)

TABLE 1 (Continued)

Specialty	GP (All)	GP (Reg. Hrs.)	IM (All)	IM (Reg. Hrs.)	PEDS	Primary Care Solo	GS	OBG (All)	OBG (Reg. Hrs.)	NEUR-ORTH.	OEU	ADCG
URBAN	-1.14	-1.14	.146	-.221	-.136	.019	.220	-.561	-.406	—	-.070	-.284
	(.03)	(.06)	(.61)	(.50)	(.69)	(.81)	(.65)	(.19)	(.27)	—	(.81)	(.05)
MDPOP	.070	.046	.122	.236	.090	-.100	-.153	.102	-.063	-.061	-.087	-.254
	(.48)	(.67)	(.34)	(.11)	(.44)	(.64)	(.07)	(.48)	(.35)	(.66)	(.41)	(.39)
SDUM1						-.176				.151	.309	-.510
						(.010)				(.18)	(.001)	(.000)
SDUM2						.015					.026	-.155
						(.83)					(.77)	(.24)
SDUM3												-.209
												(.09)
$\bar{R}^2$	.450	.436	.215	.212	.240	.386	.271	.264	.227	.368	.291	.165
N	330	241	272	200	292	560	321	335	227	221	360	362
%DQ	8.6	14.7	20.1	24.7	37.7	31.2	19.2	13.8	30.1	40.2	26.8	18.8

Specialty Abbreviations:

NEURORTH Neurosurgery and Orthopedics
OEU Ophthalmology, ENT, Urology
ACDG Allergy, Cardiovascular Disease, Dermatology, Gastroenterology
—:F level not sufficient or not included

Primary Care Solo: SDUM1=IM, SDUM2=PEDS

NEUR-ORTH.: SDUM1=NEUROS

OEU: SDUM1=OPHTH, SDUM2=URO

ADCG: SDUM1=DERMAT, SDUM2=GASTRO, SDUM3=CARDIOV

Tables 2A-C show the results. Hospital inputs have a significant effect on hospital visit productivity for all specialty groups except general surgeons, with elasticities ranging from 0.15 (OBG) to 0.48 (neuro-ortho). As might have been expected, office inputs are slightly less strongly related to hospital visits, especially for surgical specialties. Interns and residents and public control of a hospital affect only general surgeons' productivity. Bed size is negatively related to OBG productivity and unrelated to output for all other specialties.

Separate functions for surgical specialties are computed with operations as the dependent variable. Hospital inputs per physician are again significant for all groups except obstetricians (the bulk of whose "operations" are normal deliveries). Interns and residents reduce operating room productivity for general surgeons working regular hours and for all other groups except obstetricians.

Somewhat surprisingly, however, I found that hospital inputs were also related to *office* visit productivity for all specialty groups except ACDG. Elasticities tend to be smaller than those for hospital visits, especially for medical specialties, but they are uniformly significant and quantitatively important. Apparently there are important spillover effects between inputs available at the hospital and the visit productivity of physician office time.

A similarly surprising result is that there are frequently significant effects of office inputs on the productivity of physician *hospital* hours. Other things (including other inputs) equal, physicians with higher levels of office personnel inputs will see more patients per hour spent on rounds, or produce more operations per operating room hour. Of course, part of "producing" a hospital output is arranging for the patient's stay and billing for the physician's fee, clerical tasks usually performed by office personnel.

These separable functions confirm the results using the single output index. They suggest that the productivity-enhancing effects of hospital inputs apply generally to all outputs, even office visits. Finally, they indicate that operating in a hospital with more interns and residents to teach tends to be more time-consuming for the surgeon.

Multi-Output Production Functions

The final set of regressions uses an explicit multiproduct functional form. It does not require the use of an a *priori* set of weights as did the output index approach, and it does not assume that the transformation curve is linear. Since it is a more flexible specification, estimates of all coefficients should be less affected by specification error. Results shown in Table 3 are obtained by using hospital visits as the dependent variable. (Which output is selected to be dependent is not relevant for the theoretical specification of the model, but as a practical matter, the empirically estimated effects can differ depending on which output is selected as the dependent variable.) Results are highly consistent with those obtained earlier. Hospital inputs per physician constitute a significant variable for all specialties. Productivity tends to differ in public hospitals, but in different directions for different specialties. Hospital size is weakly negatively related to output, but the number of appointments and the number of interns and residents are generally unrelated to productivity.

Price Functions

Introduction

As described in Section I, the physician who has some market power should find that, other things equal, the profit-maximizing price for his or her own complementary services will tend to be lower when hospital inputs per physician are more plentiful. However, if the price for his/her services is taken as approximately given, *either because the market is competitive* or *because third party payers adhere to a maximum fee schedule*, then there may be little relationship between a *particular* physician's hospital inputs and his or her price.

I used a model of physician pricing based on the work of Pauly and Satterthwaite (1979), which permits varying degrees of competitiveness. In this model, market equilibrium price is assumed to depend upon market demand per physician, the degree of competition in the market for physicians' services, and the marginal opportunity cost of these services. The degree of competition in turn is assumed to depend upon the extent of consumer information about physician price and quality.

There are at present no direct measures of consumer information. Pauly and Satterthwaite suggest and test several proxy variables, all of which performed well in their analysis. They suggest (based on Satterthwaite's 1978 work) that consumer information may be inversely related to the number of physicians in the consumer's market area. The intuitive argument for this proposition is that in a market area with few physicians (a small town or self-contained neighborhood, for example) physician reputations for price and quality will be well-developed, and each consumer will get accurate information from his or her friends. Conversely, in a market area with many physicians (for example, the downtown business district of a large city), it will be difficult for a consumer to get accurate information on any particular physician, and it will be hard to remember what friends say about a large number of different physicians.

Thus, one proxy measure of consumer information is the number of physicians in the consumer's market area. Given the level of this variable, the number of friends with whom the consumer is able to exchange information will also be related to the level of information he or she will achieve. Proxy measures for such "information flow" notions, available in census data, would also include the proportion of families which have moved or the proportion headed solely by a female. In both cases, the assumption is that (other things equal) such families will have more difficult access to information.

TABLE 2A

Separate Production Functions
Dependent Variable: LN Hospital Visits
(Significance Level In Parentheses)

SPECIALTY	GP (ALL)	GP (Reg.Hrs.)	IM (ALL)	IM (Reg.Hrs.)	PEDS	Prim. Care Solo	GS	OBG (ALL)	OBG (Reg.Hrs.)	NEUR-ORTH	OEU	ADCG
LNHOSPHRS	.793	.725	.571	.536	.694	.728	.460	.557	.558	.499	.710	.854
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
GROUPSIZE	—	.049	-.033	.144	.268	—	.133	.378	.274	.166	.210	.194
		(.69)	(.76)	(.31)	(.006)		(.19)	(.000)	(.006)	(.12)	(.10)	(.08)
SIZESQ	.009	.020	.006	-.016	-.031	—	-.008	-.039	-.027	-.018	-.012	-.014
	(.07)	(.25)	(.67)	(.38)	(.01)	—	(.52)	(.000)	(.04)	(.23)	(.57)	(.35)
NURSHR	.007	.007	.004	.004	.002	.003	.005	.004	.003	.002	.003	-.002
	(.002)	(.004)	(.10)	(.16)	(.33)	(.10)	(.13)	(.01)	(.13)	(.48)	(.22)	(.40)
OTEMHR	.006	.007	.0006	.002	—	.002	.001	.002	.003	-.0009	.002	-.00001
	(.008)	(.005)	(.78)	(.52)	—	(.17)	(.71)	(.08)	(.06)	(.74)	(.25)	(.99)
EMHRSQ	-.00001	-.00001	-.000002	-.000006	.0000002	-.000002	-.000004	-.000003	-.000002	-.000003	-.000001	-.000004
	(.04)	(.07)	(.74)	(.44)	(.98)	(.57)	(.74)	(.03)	(.21)	(.77)	(.75)	(.43)
LNSUPPLIES	.010	—	.021	.013	.016	.024	.040	.036	.035	.020	.033	.027
	(.64)	—	(.41)	(.65)	(.48)	(.21)	(.10)	(.07)	(.14)	(.46)	(.15)	(.26)
LNHOSSIZE	.019	-.013	-.114	-.199	-.085	-.034	-.033	-.174	-.128	-.036	-.412	.150
	(.78)	(.87)	(.25)	(.11)	(.36)	(.56)	(.74)	(.03)	(.20)	(.74)	(.002)	(.12)
LNHEMP/SMD	.193	.319	.361	.380	.231	.268	.142	.151	.168	.475	.396	.148
	(.05)	(.006)	(.002)	(.007)	(.04)	(.001)	(.21)	(.09)	(.11)	(.001)	(.000)	(.17)
IR/SMD	.433	.297	-.264	-.209	.036	-.052	.849	.235	.429	-.056	.232	-.012
	(.34)	(.52)	(.23)	(.39)	(.85)	(.78)	(.05)	(.27)	(.14)	(.30)	(.48)	(.83)
YRGRAD	-.013	-.027	-.021	-.015	-.002	-.013	-.025	.002	.015	-.014	-.015	-.018
	(.22)	(.03)	(.09)	(.42)	(.84)	(.15)	(.09)	(.87)	(.39)	(.35)	(.22)	(.16)
YRGRADSQ	.0002	.0003	.0001	.0001	-.000008	.00009	.0003	-.0001	-.0004	.00002	.0001	.0003
	(.29)	(.05)	(.44)	(.75)	(.96)	(.48)	(.27)	(.41)	(.16)	(.93)	(.41)	(.11)
BCDUM	-.138	-.068	.162	.212	-.053	-.029	.351	.009	-.070	.126	.045	-.046
	(.28)	(.63)	(.13)	(.11)	(.62)	(.72)	(.001)	(.92)	(.52)	(.30)	(.66)	(.68)
PUBLIC	.140	.029	-.116	-.026	.108	.035	.286	-.189	-.964	—	.332	-.103
	(.22)	(.83)	(.48)	(.89)	(.47)	(.74)	(.06)	(.10)	(.69)	—	(.009)	(.53)

(continued)

TABLE 2A

SPECIALTY	GP (ALL)	GP (Reg.Hrs.)	IM (ALL)	IM (Reg.Hrs.)	PEDS	Prim.Care Solo	GS	OBG (ALL)	OBG (Reg.Hrs.)	NEUR-ORTH	OEU	ADCG
APPOINTS	.012	.014	-.007	-.008	-.005	.013	-.107	-.010	-.011	-.001	-.005	.008
	(.36)	(.28)	(.46)	(.39)	(.48)	(.35)	(.17)	(.19)	(.17)	(.90)	(.60)	(.41)
URBAN	-.083	-.044	.310	.536	-.095	.050	.082	-.131	-.032	-.048	.310	-.299
	(.52)	(.77)	(.07)	(.01)	(.55)	(.65)	(.57)	(.30)	(.84)	(.74)	(.01)	(.10)
MDPOP	-.447	-.177	—	-(.341)	-.886	-.075	-1.216	-.109	-.197	-.059	-.065	-.401
	(.54)	(.85)	—	(.42)	(.08)	(.80)	(.002)	(.77)	(.68)	(.90)	(.85)	(.28)
SDUM1						.116				.248	.213	-.039
						(.22)				(.04)	(.07)	(.82)
SDUM2	—		—	—	—	-.093	—	—	—	—	.492	.265
						(.36)					(.00)	(.12)
SDUM3												.261
												(.11)
$\bar{R}^2$	.518	.518	.301	.292	.394	.459	.249	.397	.352	.340	.543	.648
N	290	213	263	195	277	510	316	323	220	215	323	276

SDUM1=IM
SDUM2=PEDS

SDUM1=DERMAT
SDUM2=GASTRO
SDUM3=CARDIOV

SDUM1=OPHTH
SDUM2=URO

SDUM1=NEUROS

Specialty Abbreviations:

NEURORTH Neurosurgery and Orthopedics
OEU Ophthalmology, ENT, Urology
ACDG Allergy, Cardiovascular Disease, Dermatology, Gastroenterology
—: F level not sufficient or not included

TABLE 2B

Separate Production Functions
Dependent Variable: LN Office-Home Visits
(Significance Levels in Parentheses)

SPECIALTY	GP (ALL)	IM	PEDS	GS	OBG	ACDG	OEU	NEUR-ORTH	OB (Reg. Hrs.)	GP (Reg. Hrs.)	IM (Reg. Hrs.)
LNOFHRS	.827	.574	.687	.578	.688	.675	.546	.705	.478	.799	.528
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
GROUPSIZE	.007	.046	.023	.119	.188	.108	.091	.142	.147	-.002	.009
	(.92)	(.49)	(.67)	(.08)	(.000)	(.22)	(.14)	(.08)	(.01)	(.94)	(.92)
SIZESQ	-.003	-.006	-.002	-.012	-.019	-.012	-.010	-.015	-.015	—	-.003
	(.75)	(.48)	(.77)	(.16)	(.006)	(.31)	(.30)	(.21)	(.05)	—	(.84)
NURSHRS	.008	.006	.005	.004	.004	.002	.005	-.0007	.002	.007	.007
	(.000)	(.000)	(.001)	(.05)	(.000)	(.21)	(.000)	(.79)	(.06)	(.000)	(.000)
OTEMPHR	.005	.003	.007	.001	.003	.002	.004	-.0008	.003	.004	.003
	(.000)	(.05)	(.000)	(.47)	(.000)	(.09)	(.000)	(.84)	(.000)	(.02)	(.06)
EMHRSQ	-.00001	-.000006	-.00002	-.000004	-.000004	-.000003	-.000008	-.000005	-.000002	-.000001	-.000001
	(.001)	(.09)	(.000)	(.65)	(.000)	(.36)	(.001)	(.44)	(.01)	(.03)	(.03)
LNSUPPLIES	.034	.020	-.016	.039	.026	-.007	.014	.024	.030	.035	.025
	(.02)	(.20)	(.23)	(.019)	(.04)	(.69)	(.25)	(.25)	(.03)	(.03)	(.20)
LNHOSSIZE	.048	.417	-.051	-.034	.056	-.042	-.087	-.017	.030	.035	.028
	(.29)	(.49)	(.36)	(.61)	(.26)	(.54)	(.18)	(.86)	(.60)	(.49)	(.73)
LNHEMP/SMD	.015	.138	.123	.319	.159	.063	.167	.182	.168	.099	.137
	(.82)	(.06)	(.06)	(.000)	(.004)	(.43)	(.002)	(.10)	(.006)	(.18)	(.13)
IR/SMD	.099	-.091	.058	-.480	-.042	-.002	-.209	.251	.099	.054	-.110
	(.75)	(.51)	(.60)	(.10)	(.76)	(.96)	(.23)	(.45)	(.56)	(.86)	(.49)
YRGRAD	.002	.109	-.007	-.012	-.003	.011	.011	-.013	.014	-.004	.006
	(.80)	(.15)	(.29)	(.23)	(.66)	(.23)	(.06)	(.27)	(.16)	(.64)	(.59)
YRGRADSQ	-.0001	-.0002	.00005	-.0002	-.00002	-.0002	-.0002	.00007	-.003	-.00008	-.00008
	(.22)	(.11)	(.58)	(.14)	(.85)	(.24)	(.06)	(.69)	(.06)	(.46)	(.66)
BCDUM	-.057	-.093	.100	—	0.33	-.108	.048	.059	-.019	-.044	-.066
	(.51)	(.16)	(.11)	—	(.55)	(.18)	(.36)	(.53)	(.76)	(.64)	(.44)
PUBLIC	-.124	—	-.129	.086	-.116	-.158	.063	-.052	-.090	-.145	-.003
	(.09)	—	(.13)	(.41)	(.11)	(.17)	(.34)	(.65)	(.27)	(.08)	(.98)
APPOINTS	.006	-.006	-.002	-.030	—	—	.003	-.010	—	-.006	-.007
	(.53)	(.30)	(.63)	(.57)	—	—	(.59)	(.49)	—	(.50)	(.26)

(continued)

TABLE 2B (Continued)

SPECIALTY	GP (ALL)	IM	PEDS	GS	OBG	ACDG	OEU	NEUR-ORTH	OB (Reg. Hrs)	GP (Reg. Hrs.)	IM (Reg. Hrs.)
	-.022	.136	.109	.147	-.089	-.173	.083	-.157	-.033	.015	.182
URBAN	(.80)	(.18)	(.24)	(.14)	(.25)	(.18)	(.19)	(.17)	(.72)	(.88)	(.17)
	-.800	-.261	-.029	.147	-.590	-.122	.182	-.235	-.649	-.625	-.469
MDPOP	(.07)	(.24)	(.91)	(.59)	(.01)	(.64)	(.31)	(.52)	(.02)	(.23)	(.10)
						.343	-.019	-.466			
SDUM1						(.002)	(.75)	(.000)			
						-.450	-.289				
SDUM2						(.000)	(.000)				
						-.432					
SDUM3						(.000)					
$\bar{R}^2$	.429	.291	.258	.352	.451	.432	.487	.547	.346	.408	.236
N	328	270	289	320	339	356	358	217	226	240	199

Specialty Abbreviations:

NEURORTH Neurosurgery and Orthopedics
OEU Ophthalmology, ENT, Urology
ACDG Allergy, Cardiovascular Disease, Dermatology, Gastroenterology
—: F level not sufficient or not included

SDUM1=DERMAT
SDUM2=GASTRO
SDUM3=CARDIOV

SDUM1=OPHTH
SDUM2=URO

SDUM1=NEUROS

TABLE 2C

Separate Production Functions
Dependent Variable: LN Operations
(Significance Level in Parentheses)

SPECIALTY	GS	OBG	OBG/REG	NEURORTH	OEU
LNORHRS	.731	.566	.527	.688	.613
	(.000)	(.000)	(.000)	(.000)	(.000)
GROUPSIZE	.004	.142	.127	.188	.092
	(.95)	(.03)	(.09)	(.003)	(.28)
SIZE SQ	.001	-.008	-.007	-.019	-.005
	(.85)	(.33)	(.46)	(.04)	(.71)
NURSHR	-.0002	.0001	.0009	.002	.004
	(.91)	(.94)	(.54)	(.25)	(.01)
OTEMPHR	.0003	.003	.002	.0008	.003
	(.83)	(.004)	(.04)	(.62)	(.02)
EMHRSQ	.000001	-.0000008	-.000001	-.000005	-.000007
	(.83)	(.45)	(.35)	(.28)	(.04)
LNSUPPLIES	-.014	.019	.033	.012	.004
	(.31)	(.23)	(.06)	(.45)	(.83)
LNHOSSIZE	-.027	.016	-.092	.043	-.060
	(.55)	(.80)	(.21)	(.51)	(.53)
LNHEMP/SMD	.121	-.006	.053	.160	.312
	(.04)	(.93)	(.50)	(.07)	(.000)
IR/SMD	-.016	-.126	.264	-.062	.242
	(.94)	(.46)	(.23)	(.05)	(.30)
YRGRAD	-.012	.014	.038	.008	-.010
	(.15)	(.12)	(.004)	(.66)	(.23)
YRGRADSQ	.0002	-.0003	-.0007	-.0001	.0002
	(.13)	(.06)	(.002)	(.71)	(.20)
BCDUM	.165	.021	-.080	.082	.150
	(.006)	(.77)	(.32)	(.26)	(.04)
PUBLIC	-.074	—	-.047	-.042	.030
	(.36)	—	(.64)	(.64)	(.74)
APPOINTS	.003	.003	.002	.003	.057
	(.94)	(.60)	(.77)	(.52)	(.24)
URBAN	—	-.035	.053	-.058	.056
	—	(.72)	(.65)	(.51)	(.54)
MDPOP	-.787	-.572	-.551	-.169	-.040
	(.001)	(.06)	(.14)	(.59)	(.87)
SDUM1				-.289	.348
				(.000)	(.000)
SDUM2					.350
					(.000)
$\bar{R}^2$	.600	.423	.364	.612	.585
N	312	318	218	204	308

Specialty Abbreviations:

NEURORTH Neurosurgery and Orthopedics
OEU Ophthalmology, ENT, Urology
—: F level not sufficient

SDUM1= NEUROS

SDUM1=OPHTH
SDUM2=URO

TABLE 3

Multiproduct Production Functions
Dependent Variable: LN Hospital Visits
(Significance Levels in Parentheses)

SPECIALTY	GS	OBG	OBG (Reg. Hrs.)	NEUR-ORTH	OEU
LNMDHRS	.622	.961	1.035	.293	1.010
	(.001)	(0)	(.000)	(.13)	(.000)
GROUPSIZE	.003	.174	.105	.042	—
	(.73)	(.038)	(.31)	(.69)	—
SIZESQ	-.0002	-.017	-.010	-.006	.016
	(1.00)	(.11)	(.46)	(.67)	(.029)
NURSHRS	.005	-.0003	.0002	.004	-.002
	(.086)	(.84)	(.93)	(.25)	(.33)
OTEMPHR	.003	.0005	.001	.002	-.002
	(.30)	(.70)	(.52)	(.55)	(.37)
EMHRSQ	-.00001	.0000005	.0000002	-.000005	.000007
	(.29)	(.74)	(.89)	(.52)	(.19)
LNSUPPLIES	.019	.018	.021	-.014	.009
	(.43)	(.35)	(.40)	(.61)	(.70)
HOSSIZE	.027	-.110	-.099	-.091	-.169
	(.78)	(.16)	(.33)	(.44)	(.081)
LNHEMP/SMD	.109	.200	.223	.414	.352
	(.33)	(.021)	(.04)	(.005)	(.002)
IR/SMD	.591	.003	.079	.519	.211
	(.15)	(.99)	(.79)	(.24)	(.53)
YRGRAD	-.016	.001	-.002	.021	-.002
	(.29)	(.91)	(.93)	(.45)	(.90)
YRGRADSQ	.0002	-.0001	-.00008	-.0006	-.00006
	(.38)	(.59)	(.80)	(.285)	(.76)
BCDUM	.272	-.015	-.045	-.080	-.062
	(.010)	(.86)	(.69)	(.50)	(.57)
PUBLIC	.289	-.272	-.155	-.001	.251
	(.050)	(.016)	(.28)	(.95)	(.059)
APPOINTS	-.097	-.012	-.013	-.010	.083
	(.18)	(.11)	(.127)	(.60)	(.23)
URBAN	-.037	-.026	.026	-.100	.237
	(.80)	(.83)	(.87)	(.49)	(.077)
MDPOP	-.698	-.156	.329	-.380	.176
	(.082)	(.68)	(.53)	(.45)	(.660)
LNOFFVIS	-.061	.169	.145	.029	-.224
	(.42)	(.074)	(.28)	(.73)	(.84)
LNOPNS	.193	.116	.217	-.063	.353
	(.017)	(.14)	(.059)	(.54)	(.000)
VWOTPT	.001	.0002	-.00004	.0009	.0004
	(.000)	(.16)	(.87)	(.001)	(.16)

(continued)

TABLE 3 (Continued)

SPECIALTY	GS	OBG	OBG (Reg. Hrs.)	NEUR-ORTH	OEU
SDUM1				.179	.717
				(.21)	(.000)
SDUM2					.395
					(.003)
SDUM3					
$\bar{R}^2$	.292	.356	.256	.260	.469
N	308	312	214	198	293

SDUM1=NEUROS

Specialty Abbreviations

NEURORTH Neurosurgery and Orthopedics
OEU Ophthalmology, ENT, Urology

SDUM1=OPHTH
SDUM2=URO

Measures of these concepts are available only for metropolitan areas, but an entire standard metropolitan statistical area is probably larger than the consumer's market area. If market areas are defined by the time or distance the consumer is willing to travel, however, the number of physicians per square mile will be correlated with the number of physicians in the market area. Finally, to recognize the fact that it takes different amounts of time to travel a given distance in different cities, some measures of the geography of the market area are also included.

Pauly and Satterthwaite used data aggregated to the level of the metropolitan area, so they did not have to be concerned about the difference between an individual physician's marginal cost and the average (over all physicians in the market area) marginal cost of physician services. In addition, they concentrated on the fee for office visits for primary care physicians, which is generally not covered by insurance. In the work presented here, however, we need to consider insurance coverage (as an influence on demand) and marginal cost at both the individual physician and at the market level.

The Price Model

Formally, we may represent these notions by writing the price function p^{ij} for the fee of physician i in city j as:

$$P^{ij} = f(MD^j, MA^j, IF^j, W^j, H^j, MP^j, Y^j, Y^i, W^i, Z^i, H^i)$$

where

MD^j = physician density per square mile in city j

MA^j = variables describing the extent of the typical market area in city j

IF^j = information flow variables for the residents of city j

W^j = vector of input prices and cost of living in city j

H^j = vector of city-wide hospital input levels and characteristics in city j

MP^j = physician-population ratio in city j

Y^j = vector of demand variables (including insurance coverage) for the population of city j

Y^i = vector of specific demand variables (including insurance coverage) for the patients treated by practice i

W^i = vector of input prices paid by practice i (at both office and hospital)

Z^i = vector of practice i's characteristics, representing either efficiency proxies or output characteristics

H^i = hospital inputs and characteristics at the hospital used by practice i.

These influences on the physician's fee level may be measured in the following ways:

Competitive Variables (MD^j, MA^j, and IF^j)

Pauly and Satterthwaite suggest that the average level of consumer information about prices and quality should be the primary determinant of the extent of competition. They hypothesize that the more physicians in the consumer's market area, the less accurate will be his or her level of information about any physician. If market areas are of equal size (in terms of square miles), a reasonable proxy for the number of physicians would be physician density per square mile in the urban area. In order to adjust for differences in transportation time and cost which may make the size of market areas vary, I used population density in the urban area of the SMSA (PODENS) as a proxy.[5]

Measures of the extent of consumer information also include percent of households moved in the last five years (PCTMOVED) and percent of households headed by a female (PCTFEMHEAD). The argument here is that in both cases, such households are likely to have poorer than average information on the price and quality of physicians in their community.

Market Wage Rate (W^j)

This notion is measured both by the wage rate for retail employees (RETWAGES) and the level of payroll expense per full-time employee at metropolitan area hospitals (SMSAHOSPWAGES).

Market Area Hospital Inputs per Physician (H^j)

Hospital personnel per patient care physician in the metropolitan area (SMSAHEMP/MD) provides a measure.

Physicians, *per Capita* in Market (MP^j)

This concept is measured either by medical specialists and GPs *per capita* (for GPs, medical specialists, ophthalmologists, ENT, and urologists) or surgical specialists *per capita* for other surgical specialties (MD/POP). These variables measure marginal opportunity cost of physician time as well as possible influences of induced demand.

Market Demand Variables (Y^j)

These variables include median family income (MFAMINC) and the percent of SMSA population over age 65 (SMSAPCTOVER 65). There are no SMSA level measures of the extent of private insurance coverage. I include the percent SMSA population on AFDC as a measure of aggregate Medicaid coverage (PCTAFDC), and percent population black (PCTBLACK), to account for the possibility of more severe health problems.

[5]Pauly and Satterthwaite (1979) used some other variables which I found statistically insignificant with this data set. Consequently, they are not used in these regressions.

Practice-Specific Demand Variables (Y^i)

These include the fraction of *this physician's* patients with Medicare or Medicaid (PCTMECARE or PCTMEDAID) and the fraction of his or her patients with no insurance coverage (PCTNOINS).

Practice-Specific Input Costs (W^i)

These costs include wage rates (payroll expense per labor-hour) paid to practice employees (PRACWAGEIND) and annual payroll expense per employee at the hospital used by physician i (HOSPWAGES).

Practice Characteristics (Z^i)

Practice size (GROUPSIZE), board certification status of physician (BCDUM), ownership by the practice of a lab (OWNLAB), etc., are included in this category.

Practice Specific Hospital Inputs and Characteristics (H^i)

These include hospital inputs per staff physician (HEMP/SMD), interns and residents per staff physician (IR/SMD), hospital control (PUBLIC), size (HOSSIZE), etc.

Some of these variables are possibly endogenous. I therefore also use 2SLS with physicians *per capita* and physician density as endogenous variables (MDSQMILE).

A final consideration: the extent of insurance coverage shifts aggregate demand out and should be associated with higher prices. But for those types of care typically covered by "reasonable and customary charge" (RCC) insurance, insurance also sets what is virtually a minimum price, the RCC maximum. There is, after all, little point in charging less than the maximum. This implies that, for insured services, individual practice characteristics (other than the extent of insurance coverage) may have little to do with price.

Appendix Table A2 lists the new variables added for these regressions and their means and standard deviations. Results are presented in Tables 4 and 5 for two price measures and two estimation methods: price measures include usual fee for a routine followup office visit (primarily uninsured) and the usual fee for an inpatient hospital visit (primarily insured, and often included in the surgical fee for surgical specialties). Results are presented using both OLS and 2SLS. Because of the large number of candidate variables and because of the evidence of high collinearity among many of them, we present OLS results at two steps: the step which maximizes $\bar{R}^2$ using a stepwise procedure with a F test for selection, and the step using all variables. The 2SLS results are presented with a set of independent variables reduced by deleting those which were usually insignificant in the OLS regressions. While these are admittedly *ad hoc* procedures, they probably give an adequate summary of which variables are important and which are not.

Results

I will first comment on the influence of hospital inputs on prices as measured by the office fee. Recall that the office visit could be either a substitute or a complement for hospital outputs and inputs. The coefficient on the level of hospital inputs at the particular physician's hospital is usually negative, but it is not statistically significant. However, the SMSA-wide level of hospital personnel per patient care physician is negatively related to price for all specialty subgroups, and it is significant at the 20 percent level or better for four out of the eight groups (Table 4A). A similar pattern is shown in the 2SLS results in Tables 4-7, except that, as is often the case, significance levels are somewhat lower. The results are consistent with the view that (a) hospital inputs reduce physician marginal cost but (b) the market for physicians' office visits is competitive enough that overall physician fees in the market, rather than those of just the physicians using the hospital, are affected.

Other variables tend to have signs consistent with the Pauly-Satterthwaite model. Doctor density generally has a positive and significant effect on price in the OLS regressions (except for two more-heavily insured surgical specialties), but it is less consistent for the 2SLS regression. The doctor-population ratio is rarely significant. The information flow variables "percent moved" and "percent female headed households" have the expected positive signs, and each is significant in more than half the subsamples. Market demand variables—percent over 65, family income—have the predicted positive signs. The only practice-level demand variable which is consistently significant is percent of patients with no insurance, which tends to be negatively related to price, especially for primary care specialties. (Note that the price measure I am using is gross price billed, rather than the theoretically more appropriate net price received). Finally, input price levels, whether measured by hospital wage rates or practice wage rates, are positively related to price.

The 2SLS results for these kinds of variables also display similar patterns but lower significance levels. The only noteworthy difference is that, in the 2SLS regression, the positive effect of doctor density on price tends to be confined to primary care specialties, where insurance coverage is low.

Tables 5A and 5B show the results of similar regressions with the hospital visit fee as the dependent variable. Metropolitan area hospital inputs per physician again tend to have negative signs, especially for the primary care specialties. For the surgical specialties, the more heavily insured fees used in these regressions may depend much more on insurance firm policies than on supply and demand conditions, so the low $\bar{R}^2$ and anomalous signs may be of little import.

TABLE 4A

Price Functions
Regressions of Usual Fee for Follow-up Office Visit on Practice Input Prices, Practice and Physician Characteristics, Hospital Input Prices, Inputs and Characteristics, and SMSA Characteristics, Ordinary Least Squares
(Significance Levels in Parentheses)
(SMSA Physicians Only)

SPECIALTY	GP (ALL)		IM (ALL)		PEDS	
STEP	MAX $\bar{R}^2$	ALL VARS	MAX $\bar{R}^2$	ALL VARS	MAX $\bar{R}^2$	ALL VARS
GROUPSIZE		-.419		-.262	.316	.495
		(.54)		(.76)	(.02)	(.24)
SIZESQ		.032		.070		-.024
		(.72)		(.57)		
PRACWAGEIND	.642	.472	1.66	1.69		-.128
	(.17)	(.39)	(.01)	(.02)		(.82)
PCTBLACK		-.004			.040	.033
		(.74)			(.001)	(.01)
HOSSIZE		—		.002		.001
				(.29)		(.31)
OWNLAB		—	-.109	-1.18		-.203
		.	(.11)	(.10)		(.72)
HEMP/SMD	-.066	-.059	-.064	-.086	.0005	-.012
	(.38)	(.50)	(.34)	(.24)	(.99)	(.89)
BCDUM	.838	.776		-.305	.922	.907
	(.19)	(.28)		(.63)	(.03)	(.05)
PUBLIC		.604		-.655		
		.49		(.56)		
YRGRAD		.023		-.022		.007
		(.82)		(.76)		(.90)
YRGRADSQ		-.0004	-.0008	-.0005	.0004	.0003
		(.80)	(.01)	(.60)	(.19)	(.71)
RETWAGES	1.35	.730	1.50	1.46	1.90	1.73
	(.03)	(.41)	(.06)	(.15)	(.002)	(.02)
HOSPWAGES		.00006		.0001		
		(.79)		(.69)		
PCTNOINS		-.005	-.062	-.060		-.007
		(.80)	(.03)	(.05)		(.56)
PCTMEDAID		-.003	-.021	-.020	.042	-.036
		(.86)	(.26)	(.32)	(.005)	(.03)
PCTMECARE	.020	.015		.003	-.006	-.056
	(.08)	(.26)		(.82)	(.07)	(.13)
SMSAHEMP/MD		-.019	-.083	-.073		-.020
		(.67)	(.16)	(.27)		(.71)
SMSAHOS WAGES		.018		-.053	.278	.453
		(.87)		(.63)	(.15)	(.09)
PCTAFDC		-.053	.081	.071	.069	.057
		(.50)	(.004)	(.02)	(.02)	(.09)
POPDENS		.0001		-.0002	-.0006	-.0008
		(.81)		(.77)	(.02)	(.24)
PCTFEMHEAD		.141	.280	.284	-.177	-.159
		(.47)	(.17)	(.19)	(.20)	(.32)
PCTMOVED	.043	.050	.087	.090		.038
	(.20)	(.29)	(.06)	(.09)		(.38)
MD/POP		—		-1582		-2324
				(.74)		(.55)

(continued)

TABLE 4A (Continued)

SPECIALTY	GP (ALL)		IM (ALL)		PEDS	
STEP	MAX $\bar{R}^2$	ALL VARS	MAX $\bar{R}^2$	ALL VARS	MAX $\bar{R}^2$	ALL VARS
MD/ SQMILE	.692	.346	1.14	1.58	1.35	1.73
	(.02)	(.64)	(.000)	(.28)	(.001)	(.16)
MFAMINC		.0003		.00004		-.0002
		(.27)		(.91)		(.49)
SMSAPCT OVER65		5.60	19.69	16.22	14.70	14.12
		(.61)	(.12)	(.28)	(.10)	(.17)
CONSTANT	.657	-1.49	-2.00	-1.74	2.196	-1.68
	(.85)	(.80)	(.70)	(.80)	(.48)	(.77)
$\bar{R}^2$	.222	.144	.404	.372	.301	.277
N	144	144	189	189		202

(continued)

Note: See Technical Note B for listing of variables.

—: F level not sufficient.

TABLE 4A (Continued)

SPECIALTY	OEU		ACDG	
STEP	MAX $\overline{R}^2$	ALL VARS	MAX $\overline{R}^2$	ALL VARS
GROUPSIZE		.347		-.340
		(.74)		(.71)
SIZESQ		-.023		.067
		(.89)		(.60)
PRACWAGEIND	.842	1.03		.306
	(.27)	(.21)		(.70)
PCTBLACK		-.013		-.009
		.55		(.69)
HOSSIZE		-.002		.001
		(.28)		(.47)
OWNLAB	1.64	2.75		-.239
	(.05)	(.05)		(.77)
HEMP/SMD	-.054	-.037	.002	.002
	(.72)	(.83)	(.88)	(.87)
BCDUM	-1.31	-1.28		.331
	(.12)	(.19)		(.68)
PUBLIC		.932		-.818
		(.52)		(.53)
YRGRAD		.024	-.173	-.183
		(.84)	(.05)	(.06)
YRGRADSQ	-.0007	-.0009	.002	.002
	(.18)	(.61)	(.22)	(.20)
RETWAGES	2.37	1.96	1.50	.974
	(.06)	(.20)	(.09)	(.41)
HOSPWAGES	-.0003	-.0003		
	(.26)	(.30)		
PCTNOINS	.035	.033		-.030
	(.28)	(.32)		(.90)
PCTMEDAID		.009		.441
		(.76)		(.88)
PCTMECARE		-.006	.035	.033
		(.77)	(.04)	(.09)
SMSAHEMP/MD		-.039	-.119	-.129
		(.71)	(.05)	(.08)
SMSAHOSWAGES	.404	.382	.550	.605
	(.04)	(.10)	(.001)	(.002)
PCTAFDC	.144	.162	.081	.083
	(.002)	(.002)	(.03)	(.04)
POPDENS		.0009		-.001
		(.51)		(.21)

(continued)

TABLE 4A (Continued)

SPECIALTY	OEU		ACDG	
STEP	MAX $\bar{R}^2$	ALL VARS	MAX $\bar{R}^2$	ALL VARS
PCTFEMHEAD	.514	.582	.507	.625
	(.04)	(.04)	(.04)	(.03)
PCTMOVED	.091	.100		.043
	(.13)	(.18)		(.46)
MD/POP		2679		-8366
		(.71)		(.14)
MD/SQMILE	.878	-.603	-.617	1.68
	(.09)	(.81)	(.13)	(.34)
MFAMINC		.0002		.526
		(.69)		(.90)
SMSAPCT	41.01	45.47	15.81	18.15
OVER65	(.01)	(.01)	(.24)	(.23)
SDUM1		-1.22		-.367
		(.25)		(.74)
SDUM2		-1.98	3.06	2.86
		(.21)	(.001)	(.02)
SDUM3			1.68	1.51
			(.09)	(.21)
CONSTANT	-15.94	-18.02	-2.26	.341
	(.03)	(.08)	(.67)	(.97)
$\bar{R}^2$	.285	.257	.236	.204
N	243	243	273	273

	OEU	ACDG
	SDUM1=OTO	SDUM1=DERMAT
	SDUM2=URO	SDUM2=GASTRO
		SDUM3=CARDIOV

Specialty Abbreviations:

OEU Ophthalmology, ENT, Urology
ACDG Allergy, Cardiovascular Disease, Dermatology, Gastroenterolgy

(continued)

TABLE 4A (Continued)

SPECIALTY	GS		OBG		NEURORTH	
STEP	MAX $\bar{R}^2$	ALL VARS	MAX $\bar{R}^2$	ALL VARS	MAX $\bar{R}^2$	ALL VARS
GROUPSIZE		.314	-.443	-.495	1.19	1.21
		(.79)	(.19)	(.16)	(.26)	(.27)
SIZESQ		-.064		—	-.220	-.203
		(.68)		—	(.14)	(.20)
PRACWAGEIND	1.19	1.32	1.31	.967	2.21	2.32
	(.25)	(.25)	(.22)	(.39)	(.04)	(.03)
PCTBLACK		.043		-.007	-.51	.053
		(.12)		(.81)	(.07)	(.08)
HOSSIZE		-.002		.002		-.001
		(.44)		(.46)		(.62)
OWNLAB		.774	-1.95	-1.87		-.673
		(.49)	(.07)	(.09)		(.79)
HEMP/SMD	-.062	-.028	-.066	-.083	.072	.075
	(.71)	(.88)	(.51)	(.44)	(.75)	(.75)
BCDUM		-.304		.343		-1.51
		(.80)		(.77)		(.31)
PUBLIC		1.17		-1.07	-4.97	-5.40
		(.59)		(.54)	(.02)	(.02)
YRGRAD		—	-.002	.046		-.035
		—	(.08)	(.79)		(.92)
YRGRADSQ		—		-.003		.002
		—		(.38)		(.79)
RETWAGES		-.471		2.82	3.40	2.87
		(.79)		(.18)	(.03)	(.12)
HOSPWAGES	.0008	.0008		-.0002		.0003
	(.01)	(.07)		(.53)		(.56)
PCTNOINS	-.068	-.070		-.023		—
	(.22)	(.25)		(.64)		—
PCTMEDAID		-.051		-.031	-.123	-.131
		(.24)		(.48)	(.02)	(.02)
PCTMECARE	-.035	-.032	-.045	-.050	.064	.078
	(.14)	(.21)	(.26)	(.22)	(.04)	(.03)
SMSAHEMP/MD		-.131	-.426	-.493	-.366	-.376
		(.38)	(.002)	(.008)	(.007)	(.01)

(continued)

TABLE 4A (Continued)

SPECIALTY	GS		OBG		NEURORTH	
STEP	MAX $\bar{R}^2$	ALL VARS	MAX $\bar{R}^2$	ALL VARS	MAX $\bar{R}^2$	ALL VARS
SMSAHOS	-.151	-.198		-.099		.138
WAGES	(.34)	(.28)		(.65)		(.82)
PCTAFDC	.128	.135	.186	.184		—
	(.03)	(.06)	(.01)	(.02)		—
POPDENS	.0004	.002	.005	.004	.005	.005
	(.26)	(.29)	(.001)	(.01)	(.001)	(.002)
PCTFEMHEAD	1.11	.976		-.204	.470	.473
	(.000)	(.007)		(.61)	(.18)	(.21)
PCTMOVED	.131	.137		-.103	.217	.222
	(.08)	(.15)		(.34)	(.03)	(.04)
MD/POP		6218	16349	13267	20714	20934
		(.56)	(.14)	(.27)	(.07)	(.08)
MD/SQMILE		-2.86	-8.64	-7.40	-10.98	-11.35
		(.45)	(.02)	(.06)	(.006)	(.006)
MFAMINC		.0003		-.0008	-.0009	-.001
		(.53)		(.17)	(.07)	(.08)
SMSAPCT	36.68	47.59		-19.10		-12.92
OVER65		(.07)	(.04)		(.38)	
SDUM1					2.16	2.17
					(.05)	(.06)
CONSTANT		-20.59	12.31	21.43	-19.23	-14.97
		(.08)	(.01)	(.10)	(.10)	(.26)
$\bar{R}^2$		.244	.208	.179	.324	.296
N		192	230	230	149	149

Special Abbreviations:

NEURORTH Neurosurgery and Orthopedics

SDUM1=NEUROS

TABLE 4B

Price Functions

Regression of Routine Fee For Follow-up Office Visits On Practice Input Prices, Practice and Physician Characteristics, Hospital Input Prices, Inputs and Characteristics and SMSA Characteristics Two-Stage Least Squares (SMSA Physicians Only) (Asymptotic t-Statistics in Parentheses)

SPECIALTY	GP	IM	PEDS	GS	OBG
PRACWAGEIND	.731	1.94	-.036	1.62	.498
	(1.3)	(2.0)	(-.57)	(1.4)	(.44)
PCTBLACK	-.008	.016	.020	.049	-.004
	(-.59)	(.65)	(1.0)	(1.6)	(-.14)
HOSSIZE	.0001	.00004	.002	.0004	.002
	(.09)	(.01)	(1.7)	(.14)	(.60)
HEMPSMD	-.088	-.081	-.123	-.053	-.103
	(-.89)	(-.78)	(-1.0)	(-.27)	(-.96)
BCDUM	-.994	-.846	1.04	-.092	.528
	(1.3)	(-.91)	(2.1)	(-.08)	(.45)
PUBLIC	-.020	-1.75	.389	1.55	-1.51
	(-.03)	(-1.0)	(.43)	(.63)	(-.84)
YRGRAD	.005	-.054	.024	-.007	-.087
	(.22)	(-1.7)	(1.1)	(-.13)	(-1.5)
RETWAGES	.537	3.73	1.51	.452	2.01
	(.55)	(2.2)	(1.6)	(.23)	(.94)
HOSPWAGES	-.00003	-.00003	-.0002	.0007	-.00007
	(-.11)	(-.07)	(-.66)	(1.6)	(-.18)
PCTNOINS	-.013	-.098	.002	-.055	-.055
	(-.64)	(-1.9)	(.14)	(-.83)	(-1.1)
PCTMEDAID	-.005	-.017	-.020	-.047	-.024
	(-.29)	(-.53)	(-.85)	(-1.1)	(-.54)
PCTMECARE	.025	.017	-.028	-.040	-.069
	(1.6)	(.80)	(-.56)	(-1.5)	(-1.6)
SMSAHOSWAGES	.004	-.108	.612	-.295	-.163
	(.03)	(-.75)	(1.6)	(-1.5)	(-.73)
POPDENS	-.003	.008	-.005	.003	.009
	(-1.2)	(1.4)	(-1.4)	(1.2)	(2.9)
PCTFEMHEAD	.127	-.024	-.132	.965	-.104
	(.64)	(-.58)	(-.68)	(2.6)	(-.25)
SMSAHEMPMD	-.042	-.018	.053	-.201	-.563
	(.78)	(-.16)	(.66)	(-1.2)	(-2.8)
MD/POP	17445.73	55231	-29562	17702	48049
	(-1.2)	(1.4)	(-1.3)	(.86)	(1.7)
MDSQMILE	6.75	-13.10	10.02	-6.17	-19.87
	(1.3)	(-1.3)	(1.5)	(-1.0)	(-2.5)
MFAMINC	.0004	-.0008	.00002	.0003	-.0007
	(1.1)	(-1.2)	(.05)	(.54)	(-1.0)
SMSAPCTOVER65	-2.28	10.47	9.03	43.47	-6.46
	(-.20)	(.53)	(.76)	(2.0)	(-.30)
CONSTANT	12.78	-24.57	14.95	-18.58	4.03
	(1.3)	(-1.3)	(1.2)	(-1.4)	(.30)
N	144	189	202	192	230

(continued)

TABLE 4B (Continued)

SPECIALTY	NEURORTH	OEU	ACDG
PRACWAGEIND	2.51	.872	3.94
	(2.1)	(1.0)	(3.4)
PCTBLACK	.094	.009	.056
	(2.5)	(.38)	(1.6)
HOSSIZE	-.001	-.002	-.003
	(-.49)	(-.73)	(-1.0)
HEMPSMD	.068	.008	-.040
	(.27)	(.04)	(-1.8)
BCDUM	-1.12	-1.01	.551
	(-.07)	(-.10)	(.46)
PUBLIC	-4.58	1.67	-1.35
	(-2.0)	(1.1)	(-.68)
YRGRAD	.040	-.046	-.066
	(.54)	(-1.3)	(-1.6)
RETWAGES	3.27	2.74	5.43
	(1.7)	(1.5)	(2.1)
HOSPWAGES	.0008	-.0003	-.0003
	(1.2)	(-.76)	(-.73)
PCTNOINS	.047	.032	-.004
	(.59)	(.91)	(-.12)
PCTMEDAID	-1.31	.010	.075
	(-2.2)	(.31)	(1.5)
PCTMECARE	.086	-.011	.059
	(2.4)	(-.54)	(2.1)
SMSAHOSWAGES	-.884	.246	-.024
	(-1.1)	(1.0)	(-.08)
POPDENS	.008	.007	.006
	(2.0).	(2.3)	(.91)
PCTFEMHEAD	.256	.270	.048
	(.64)	(.75)	(.10)
SMSAHEMPMD	-.505	-.176	.176
	(2.8)	(-1.5)	(1.1)
MD/POP	59510	49328	40544
	(1.6)	(1.9)	(1.1)
MDSQMILE	-18.79	-15.10	9.77
	(-1.7)	(-2.1)	(-.90)
MFAMINC	-.0006	.0001	-.0008
	(-.72)	(.26)	(-.88)
SMSAPCTOVER65	21.46	34.78	-19.66
	(-1.1)	(1.8)	(-.89)
SDUM1	2.47	-.708	-2.12
	(2.0)	(-.62)	(-1.3)
SDUM2		.382	2.83
		(.33)	(1.6)
SDUM3			2.20
			(1.2)
CONSTANT	-18.49	-26.31	-30.18
	(-.98)	(-2.1)	(-1.3)
N	149	243	273
	SDUM1=NEUROS	SDUM1=OPHTH SDUM2=URO	SDUM1=DERMAT SDUM2=GASTRO SDUM3=CARDIOV

Specialty Abbreviations:
NEURORTH Neurosurgery and Orthopedics
OEU Ophthalmology, ENT, Urology
ACDG-Allergy, Cardiovascular Disease,
Dermatology, Gastroenterology

TABLE 5A

Price Functions
Regression of Routine Fee For Follow-up Visit to Hospital Inpatient on Practice Input Prices, Practice and Physician Characteristics, Hospital Input Prices, Inputs and Characteristics and SMSA Characteristics
Ordinary Least Squares
(Significance Levels In Parentheses)
(SMSA Physicians Only)

SPECIALTY	GP (ALL)		IM (ALL)		PEDS		GS	
STEP	Max $\bar{R}^2$	All Vars.	Max $\bar{R}^2$	All Vars.	Max $\bar{R}^2$	All Vars.	Max $\bar{R}^2$	All Vars.
GROUPSIZE		-1.54		.954		-.717		-2.05
		(.29)		(.48)		(.44)		(.27)
SIZESQ		.200		-.106	.072	.164		.291
		(.30)		(.58)	(.08)	(.19)		(.24)
PRAC		-.012	2.07	2.10	1.54	1.43	3.75	3.92
WAGEIND		(.99)	(.05)	(.06)	(.18)	(.25)	(.02)	(.03)
PCTBLACK		.019		-.010	.031	.034		-.026
		(.46)		(.68)	(.20)	(.24)		(.57)
HOSSIZE		-.002		—	—	.0003		-.003
		(.42)		—	—	(.88)		(.57)
OWNLAB	-2.49	-2.20		-1.36	1.63	1.60	-2.61	-2.58
	(.05)	(.12)		(.24)	(.15)	(.20)	(.12)	(.15)
HEMP/SMD	.109	.169	-.105	-.067	.292	.267	-.314	-.387
	(.51)	(.37)	(.33)	(.56)	(.09)	(.16)	(.22)	(.17)
BCDUM		-.180		-.139		1.18		—
		(.91)		(.89)		(.25)		—
PUBLIC	3.82	3.54		.981		.765		.943
	(.02)	(.07)		(.59)		(.67)		(.78)
YRGRAD		.153	-.056	-.126		-.094	-.300	-.260
		(.47)	(.12)	(.28)		(.42)	(.18)	(.27)
YRGRADSQ	-.002	-.004		.001		.001	.005	.005
	(.02)	(.23)		(.46)		(.55)	(.10)	(.14)
RETWAGES		-.978	4.03	2.80		—		.331
		(.61)	(.000)	(.07)		—		(.90)
HOSPWAGES		.0002		.0004		.0003		-.0002
		(.70)		(.36)		(.50)		(.78)
PCTNOINS		-.142	-.052	-.048		-.020		-.033
		(.72)	(.27)	(.35)		(.44)		(.73)
PCTMEDAID		-.038	-.043	-.052	-.074	-.083		.048
		(.28)	(.16)	(.15)	(.02)	(.02)		(.49)
PCTMECARE	.043	.038		-.027		-.017	-.051	-.045
	(.08)	(.18)		(.24)		(.83)	(.19)	(.26)
SMSA		-.061		-.120	-.150	-.135	.190	.323
HEMP/MD		(.53)		(.27)	(.15)	(.24)	(.28)	(.17)

(continued)

TABLE 5A (Continued)

SPECIALTY	GP (ALL)		IM (ALL)		PEDS		GS	
STEP	Max $\bar{R}^2$	All Vars.	Max $\bar{R}^2$	All Vars.	Max $\bar{R}^2$	All Vars.	Max $\bar{R}^2$	All Vars.
SMSAHOS WAGES		-.058		-.075		-.302		.373
		(.80)		(.66)		(.64)		(.19)
PCTAFDC		-.165	.065	.075		.030	.278	.307
		(.33)	(.15)	(.12)		(.69)	(.002)	(.006)
POPDENS		-.001		.00007		-.0004	-.001	-.003
		(.55)		(.63)		(.82)	(.03)	(.23)
PCTFEM HEAD	.541	.789		.280		.119	.585	.627
	(.10)	(.07)		(.43)		(.72)	(.20)	(.26)
PCTMOVED	.158	.143		.019	.165	.134		—
	(.03)	(.16)		(.83)	(.02)	(.19)		
MD/POP		-4883	9335	4442		2,099		-12734
		(.61)	(.002)	(.56)		(.81)		(.45)
MD/SQMILE	.671	2.06	1.11	2.11	1.20	1.35		3.64
	(.31)	(.53)	(.04)	(.36)	(.02)	(.63)		(.53)
MFAMINC	.0005	.0009			.0006	.0006		-.0002
	(.31)	(.16)			(.16)	(.31)		(.84)
SMSAPCT OVER65		13.12	22.29	28.00	54.21	50.84		11.18
		(.58)	(.26)	(.24)	(.008)	(.03)		(.75)
CONSTANT	-5.24	-3.71	-11.78	-6.67	-8.99	-7.79	9.37	11.76
	(.51)	(.79)	(.06)	(.54)	(.25)	(.52)	(.15)	(.47)
$\bar{R}^2$	.152	.076	.335	.303	.128	.080	.087	.038
N	144	144	189	189	202	202	192	192

—: F level not sufficient

(continued)

TABLE 5A (Continued)

SPECIALTY	OBG (ALL)		NEURORTH		OEU		ACDG	
STEP	Max $\bar{R}^2$	All Vars.	Max $\bar{R}^2$	All Vars.	Max $\bar{R}^2$	All Vars.	Max $\bar{R}^2$	All Vars.
GROUPSIZE				.618		.318		1.16
				(.67)		(.84)		(.33)
SIZESQ	-.092	-.102		-.114	.196	.141		-.173
	(.13)	(.10)		(.58)	(.02)	(.57)		(.32)
PRAC WAGEIND		-.986		.982	1.70	2.19	3.41	3.21
		(.50)		(.49)	(.13)	(.07)	(.001)	(.002)
PCTBLACK		-.032		.028		-.006		.008
		(.35)		(.46)		(.84)		(.79)
HOSSIZE		.002		—	-.009	-.009		-.001
		(.48)		—	(.002)	(.005)		(.56)
OWNLAB	-.237	-2.19		2.20	2.78	2.04	1.98	2.05
	(.10)	(.14)		(.51)	(.03)	(.33)	(.05)	(.06)
HEMP/SMD	.111	.150	.219	.299	.344	.357	-.035	-.035
	(.39)	(.28)	(.43)	(.33)	(.13)	(.16)	(.05)	(.07)
BCDUM		.551	-5.56	-5.79		.429		.710
		(.72)	(.003)	(.004)		(.77)		(.51)
PUBLIC	-4.15	-3.97	-3.04	-3.61		-.450		-.800
	(.06)	(.09)	(.25)	(.22)		(.83)		(.64)
YRGRAD	-.257	.155	.542	.584		-.038	-.376	-.340
	(.000)	(.49)	(.19)	(.19)		(.83)	(.001)	(.008)
YRGRADSQ		-.002	-.013	-.014		.0004	.004	.004
		(.61)	(.11)	(.12)		(.88)	(.009)	(.03)
RETWAGES	3.97	3.40	4.57	5.02	2.83	2.09	1.55	.757
	(.02)	(.17)	(.01)	(.04)	(.04)	(.36)	(.17)	(.65)
HOSPWAGES		-.002		-.0004		.0001		-.0002
		(.67)		(.60)		(.80)		(.62)
PCTNOINS	.116	.134	.092	.093	.103	.107		.017
	(.05)	(.05)	(.31)	(.33)	(.03)	(.03)		(.61)
PCTMEDAID		.073	-.089	-.107		.017	.110	.109
		(.20)	(.17)	(.15)		(.70)	(.003)	(.008)
PCTMECARE		—		.054		-.023	.075	.057
		—		(.24)		(.44)	(.000)	(.03)
SMSAHEMP/ MD	.362	.242		-.088		.108		-.015
	(.07)	(.31)		(.63)		(.49)		(.88)
SMSAHOS WAGES		-.168	1.85	1.85		-.461		.115
		(.55)	(.005)	(.02)		(.18)		(.66)
PCTAFDC		-.062	.140	.129	.191	.167	.057	.071
		(.56)	(.22)	(.32)	(.005)	(.03)	(.25)	(.20)
POPDENS		.001		.001		-.002		-.002

(continued)

TABLE 5A (Continued)

SPECIALTY	OBG (ALL)		NEURORTH		OEU		ACDG	
STEP	Max $\bar{R}^2$	All Vars.	Max $\bar{R}^2$	All Vars.	Max $\bar{R}^2$	All Vars.	Max $\bar{R}^2$	All Vars.
		(.25)		(.55)		(.32)		(.25)
PCTFEM			.649	.258		.204	.810	.832
HEAD		—	(.12)	(.60)		(.63)	(.01)	(.04)
PCTMOVED	.181	.228	.343	.293	.282	.272	.162	.175
	(.10)	(.10)	(.005)	(.04)	(.000)	(.01)	(.02)	(.03)
MD/POP			-19708	14022		-7816	-4712	-13543
		—	(.000)	(.36)		(.47)	(.06)	(.07)
MD/SQMILE		-1.17		-1.52		4.10		2.98
		(.61)		(.78)		(.27)		(.21)
MFAMINC		.0003	-.003	-.003		.0005		.0004
·		(.65)	(.001)	(.003)		(.46)		(.42)
SMSAPCT	-24.80	-14.92		-7.67		24.58		-3.39
OVER65	(.33)	(.60)		(.75)		(.34)		(.87)
SDUM1			3.72	3.24		-.669	-2.73	-1.82
			(.009)	(.03)		(.67)	(.02)	(.22)
SDUM2						.489		1.65
						(.84)		(.31)
SDUM3								2.18
								(.17)
CONSTANT	-17.20	-19.92	-20.48	-18.23	-23.12	-22.87	8.03	-5.85
	(.19)	(.21)	(.10)	(.30)	(.01)	(.14)	(.21)	(.58)
$\bar{R}^2$	.103	.075	.304	.268	.145	.095	.252	.229
N	239	230	149	149	243	243	273	273

SDUM1=NEUROS

SDUM2 =OPHTH
SDUM2=URO

SDUM1=DERMAT
SDUM2=GASTRO
SDUM3=CARDIOV

Specialty Abbreviation:
NEURORTH Neurosurgery and Orthopedics
OEU Ophthalmology, ENT, Urology
ACDG Allergy, Cardiovascular Disease, Dermatology, Gastroenterology

TABLE 5B

Price Functions

Regression of Routine Fee for Visit to Hospital Inpatient on Practice Input Prices, Practice and Physician Characteristics, Hospital Input Prices, Inputs and Characteristics and SMSA Characteristics Two-Stage Least Squares (SMSA Physicians Only) (Asymptotic t-Statistics in Parentheses)

SPECIALTY	GP (ALL)	IM	PEDS	GS	OBG	NEURORTH
PRACWAGEIND	.691	2.34	1.67	3.95	-.645	1.42
	(.58)	(1.9)	(1.1)	(2.1)	(-.44)	(.86)
PCTBLACK	.004	5.62	-.004	-.024	-.013	.103
	(.13)	(.19)	(-.09)	(-.49)	(-.36)	(2.0)
HOSSIZE	-.002	-.008	.002	.001	.002	.0001
	(-.90)	(-.27)	(.81)	(.25)	(.50)	(.03)
HEMP/SMD	.137	-.097	-.025	-.287	.139	.301
	(.65)	(-.74)	(-.09)	(-.91)	(1.0)	(.87)
BCDUM	.912	-.233	1.30	-.219	.537	-4.48
	(.57)	(-.20)	(1.1)	(.11)	(.35)	(-2.2)
PUBLIC	1.81	-.298	2.12	1.41	-3.16	2.52
	(.74)	(-.14)	(1.0)	(.36)	(-1.4)	(-.78)
YRGRAD	-.076	-.055	-.017	.072	-.271	-.090
	(-1.5)	(-1.4)	(-.34)	(.91)	(-.37)	(-.89)
RETWAGES	-1.39	4.15	-.658	1.42	4.08	5.74
	(-.67)	(1.9)	(-.31)	(.45)	(1.5)	(2.2)
HOSPWAGES	.0004	.0002	.0006	.0008	-.0003	.0005
	(.08)	(.52)	(-.78)	(-.12)	(-.48)	(.54)
PCTNOINS	-.034	-.087	.014	-.003	.159	.148
	(-.77)	(-1.3)	(.38)	(-.31)	(2.4)	(1.3)
PCTMEDAID	-.029	-.039	-.038	.039	.053	-.140
	(-.81)	(-.96)	(-.69)	(.54)	(.90)	(1.7)
PCTMECARE	.060	-.014	.059	-.052	-.011	.059
	(1.8)	(-.55)	(.52)	(1.2)	(-.20)	(1.2)
SMSAHEMP/MD	-.100	-.094	.018	.280	.127	-.363
	(-.87)	(-.67)	(.09)	(1.0)	(.48)	(-1.5)
SMSAHOS WAGES	-.142	-.129	.280	.406	-.314	.204
	(-.56)	(-.70)	(.31)	(1.3)	(-1.1)	(.19)
POPDENS	-.008	.007	-.013	-.003	.0001	.009
	(1.4)	(.90)	(1.5)	(-.85)	(.34)	(1.6)
PCTFEMHEAD	.808	-.002	.178	.083	-.190	.125
	(1.9)	(-.004)	(.40)	(1.4)	(-.35)	(.23)
MD/POP	-37287	48028	-74472	-20493	7816	65580
	(-1.2)	(.98)	(-1.4)	(-.62)	(.22)	(1.3)
MD/SQMILE	15.21	-10.44	24.47	5.04	-1.46	-21.47
	(1.4)	(-.82)	(1.5)	(.53)	(-.14)	(-1.4)
MFAMINC	.0008	-.0004	.001	.0006	.0005	-.002
	(1.0)	(-.49)	(1.5)	(.07)	(.55)	(-1.5)
SMSPATCT OVER65	-5.41	36.20	29.68	33.01	-33.05	-7.05
	(-.22)	(1.5)	(1.1)	(.95)	(-1.2)	(-.27)
SDUM1= NEUROS						4.04
						(2.4)
CONSTANT	27.94	-29.56	41.19	-61.52	-10.67	-3.09
	(1.4)	(-1.2)	(1.4)	(-.30)	(-.61)	(-1.2)
N	144	189	202	192	230	149

(continued)

TABLE 5B (Continued)

SPECIALTY	OEU	ACDG
PRACWAGEIND	1.95	.725
	(1.6)	(.87)
PCTBLACK	.002	.013
	(.05)	(.48)
HOSSIZE	-.006	.0004
	(-1.8)	(.17)
HEMP/SMD	.155	-.001
	(.51)	(-.08)
BCDUM	.564	.051
	(.37)	(.06)
PUBLIC	.911	-1.05
	(.42)	(-.73)
YRGRAD	-.015	-.070
	(-.29)	(-2.4)
RETWAGES	3.30	3.32
	(1.3)	(1.8)
HOSPWAGES	.0003	-.00002
	(.61)	(-.08)
PCTNOINS	.108	-.016
	(2.1)	(-.57)
PCTMEDAID	.022	-.016
	(.50)	(-.45)
PCTMECARE	-.028	.036
	(-.92)	(1.7)
SMSAHEMP/MD	.006	-.065
	(.04)	(-.58)
SMSAHOSWAGES	-.667	.549
	(-1.9)	(2.6)
POPDENS	.0010	.005
	(.23)	(1.1)
PCTFEMHEAD	-.076	.358
	(-.14)	(1.0)
MD/POP	17025	29251
	(.45)	(1.1)
MD/SQMILE	-2.12	-9.33
	(-.20)	(1.2)
MFAMINC	.0004	-.0006
	(.55)	(-.90)
SMSAPCTOVER65	10.92	20.06
	(.40)	(1.2)
SDUM1	-.673	-.007
	(-.41)	(-.01)
SDUM2	2.61	3.45
	(1.5)	(2.7)
SDUM3		(1.37)
		(1.1)
CONSTANT	-15.90	-23.02
	(-.86)	(-1.4)
N	243	273
	SDUM1=OPHTH SDUM2=URO	SDUM1=DERMAT SDUM2=GASTRO SDUM3=CARDIOV

Implications for Policy

The Medicare Economic Index

The Medicare Economic Index (MEI) currently applies a limit based on an input market basket rate of growth to arrive at maximum reimbursement levels for classes of U.S. physicians. Differential variation in prices physicians actually pay for inputs will obviously lead to inequity in the use of such standards. My research suggests, however, that there is another possible source of inequity—differences in the rate of growth in hospital inputs per physician. Such differences will lead to changes in physician real income (including the value placed on leisure) as hospital input levels change, even if the MEI accurately measured input price changes for all physicians.

Such changes can occur either because the levels of inputs themselves change or because the number of physicians among whom they are shared changes. For example, the hospital (in a market area) which is most successful in getting certificate of need (CON) approval will, other things equal, be able to provide more inputs to its physician staff. Compared to other physicians in the market area, physicians who use that hospital will have higher real income. Either their money net incomes will be greater, or they will have to work fewer hours for the same net income. On the other hand, at hospitals which experience a larger influx of physicians obtaining staff appointments, existing physicians will experience decreases in real income. These haphazard distributions of windfall gains and losses are bound to increase provider dissatisfaction with the index.

In addition to effects within market areas, there will also be effects across market areas. In cities or other market areas which experience a larger influx of physicians or larger reductions of hospital inputs (for example, because of CON), physician real incomes from Medicare business will change at differing rates, even if the Medicare index could adjust perfectly for changes in practice costs. Since the fee level for Medicare business is virtually determined by the index, the effect of decreases in hospital inputs per physician *in the market area* will be unequivocally negative; net incomes per hour spent on Medicare business will decline.[6]

But as suggested by the price functions, the effect of changes in hospital inputs on the profitability of services to non-Medicare patients, especially ambulatory visits to uninsured patients, is ambiguous. If hospital inputs per physician decrease, price may rise so much that net income does not decline. In any case, if prices do rise as these results indicate, the net income per hour from non-Medicare patients will rise relative to the net income from Medicare patients. For an

[6]It is possible, however, that these lower net incomes may be competed away as providers reduce amenities (shorter visits, poorer office staffing).

additional reason, then, in an era of declining hospital resources per physician, the Medicare Economic Index may offer financial incentives to the physician to prefer non-Medicare to Medicare patients, *even if the index correctly adjusts for changes in the physician's practice costs*. Moreover, this incentive will be greater in areas in which there have been larger decreases in hospital inputs per physician.

Hospital Appointments

It seems plausible to assume that the physician's desire for an active medical staff appointment at a particular hospital will depend in part on the income he or she can expect to earn with the use of the hospital's facilities. This is not to imply that only income matters; it is only to suggest that, other things equal, physicians will prefer an opportunity which yields more income to one that yields less income.

If physicians have correct perceptions about the income productivity of hospitals, these results suggest which kinds of hospital appointments we should expect to find in strong demand (but short supply). The principal characteristic of a hospital that was associated with higher physician productivity was simply the number of hospital employees per active staff physician. Given this variable, neither the hospital size and scope of facility nor its control generally mattered. "High input" hospitals should, therefore, be highly desirable as appointment sites.

This raises an interesting question which these results could bear on only tangentially. Why does the level of hospital employees per staff physician vary across hospitals? Is a high level indicative of a hospital whose present staff has succeeded in closing or reducing opportunities for additional members to join? Or does it indicate a hospital which, for some other reason, few physicians find desirable? If the latter explanation were correct, the cause of undesirability would not likely be lower general efficiency associated with the hospital. The reason could involve case-mix differences, although I do not think this is very plausible. The best guess is that it is explicit or (more likely) implicit closed staffing that accounts for high ratios of personnel to physicians, but at the present time I am unable to analyze individual hospital-specific variables which would be associated with closed staffing.

These results offer a new perspective on recent trends. They imply that the current rapid increases in physician supply will be associated with both competition for staff appointments and possible declining physician productivity. Second, they imply that attempts by planning bodies to limit "duplication" of facilities may be counterproductive, in the sense that lower hospital costs will be offset in part by lower physician productivity and higher physician fees.

However, while the results indicate that hospital inputs have important effects on physician productivity, the cost of these hospital inputs is high. The magnitude of the coefficients on hospital inputs and physician time suggests that, at least for the outputs measured here, there tends to be *overuse* of hospital inputs relative to the physician's time, a result which has also been established using hospital data (Pauly, 1980). While the omission of admissions as an output weakens this conclusion, the results are consistent with the theory that hospitalization insurance prompts overuse of hospital inputs relative to physician inputs.[7]

Conclusion

The optimal organization of the health care system requires minimization of all costs of producing whatever level of care is chosen. Such minimization in turn requires consideration of spillover effects between the physician and hospital sectors. This study continues the piecemeal examination of those relationships, and has made the contribution of discovering that there are specific (and large) interaction effects, with some important direct policy implications of their own.

To gain insight into the overall optimization problem, however, more complete information is required in the health care *system*. Data on hospital and physician inputs and outputs need to be linked. Insurance is likely to be found to be the culprit in inefficiency detected by the use of such data, but at least we would then have a better understanding of the directions for reform.

[7]See Pauly (1980) for a further discussion of this theory.

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Technical Note A

TABLE A1

Means and Standard Deviations of Physician Time and Characteristics, Practice Inputs, and Hospital Inputs and Characteristics by Specialty (Owner-Physicians Data) for the Production Function Regressions

	GP(ALL)		GP (REG.HRS.)		IM (ALL)		IM (REG.HRS.)		PEDS	
SPECIALTY	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
LMDHRS	4.10	.33	4.11	.30	4.12	.30	4.14	.24	4.05	.26
GROUPSIZE	1.65	1.27	1.58	1.19	1.96	1.68	1.90	.63	2.16	1.65
SIZESQ	4.34	9.10	3.90	8.31	6.65	12.75	6.24	11.88	7.41	12.94
NURSHRS	41.57	37.44	42.04	39.17	33.99	37.89	34.71	37.29	34.41	31.85
OTEMPHR	54.92	41.16	54.55	42.56	50.71	41.46	47.43	36.92	44.05	31.26
EMHRSQ	13449.09	18316.10	13710.42	19779.53	11384.07	21933.62	10514.06	19478.81	8639.77	13662.02
LSUPPLIES	7.46	2.17	7.36	2.16	7.08	2.12	7.00	2.13	7.24	2.18
LHOSSIZE	5.06	.94	5.07	.94	5.70	.68	5.74	.64	5.70	.63
LHEMP/SMD	2.11	.55	2.09	.53	1.91	.52	1.89	.55	1.87	.53
IR/SMD	.04	.11	.04	.12	.12	.28	.13	.32	.12	.28
YRGRAD	26.73	13.34	28.04	13.58	24.53	12.42	24.27	11.20	22.57	12.12
YRGRADSQ	892.15	883.24	970.05	958.77	755.50	831.90	713.52	673.22	655.47	825.42
BCDUM	.14	.35	.15	.35	.41	.49	.39	.49	.62	.49
PUBLIC	.23	.42	.22	.42	.11	.32	.12	.32	.12	.33
APPOINTS	1.75	3.25	1.85	3.79	1.84	5.35	1.98	6.24	1.99	6.12
URBAN	.54	.50	.56	.50	.79	.41	.81	.39	.82	.39
MDPOP	.13	.08	.13	.08	.21	.16	.21	.15	.20	.12
LVWOTPT	5.15	.82	5.18	.72	4.88	.71	4.93	.68	5.09	.65

(continued)

TABLE A1 (Continued)

	GS		OBG		OBG (REG.HRS.)		NEURORTH	
SPECIALTY	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
LMDHRS	4.13	.29	4.09	.32	4.13	.27	4.11	.31
GROUPSIZE	1.96	1.73	2.19	1.56	2.36	1.64	2.25	.59
SIZESQ	6.85	13.79	7.24	11.50	8.24	12.39	7.57	10.94
NURSHRS	22.52	25.70	34.06	40.37	36.38	44.99	19.22	24.20
OTEMPHR	43.28	31.71	50.84	66.98	48.46	45.88	67.64	44.12
EMHRSO	6338.94	9773.07	14575.76	77251.08	13232.29	66712.24	10701.51	15969.49
LSUPPLIES	6.53	2.02	6.79	2.05	6.64	2.11	6.52	2.20
LHOSSIZE	5.51	.72	5.71	.62	5.72	.60	5.74	.60
LHEMP/SMD	1.96	.52	1.94	.51	1.94	.53	1.89	.52
IR/SMD	.07	.14	.10	.22	.09	.23	.15	1.17
YRGRAD	26.89	11.16	23.33	11.06	22.49	10.50	21.21	10.09
YRGRADSQ	847.34	709.71	666.13	703.73	615.81	611.17	551.38	648.21
BCDUM	.65	.48	.61	.49	.58	.50	.69	.46
PUBLIC	.12	.33	.14	.34	.15	.35	.13	.33
APPOINTS	1.53	.64	1.76	4.83	1.89	5.84	2.10	6.42
LHEMP/SMD	.92	.24	.99	.22	.98	.22	1.01	.22
URBAN	.70	.46	.81	.39	.82	.38	.80	.40
MDPOP	.17	.14	.19	.12	.18	.12	.19	.12
LVWOTPT	5.59	.78	5.72	.93	5.82	.89	5.58	.84
SDUM1							.51	.50

SDUM1=NEUROS

Specialty Abbreviations:

NEURORTH Neurosurgery and Orthopedics

(continued)

TABLE A1 (Continued)

SPECIALTY	OEU		ACDG	
	MEAN	SD	MEAN	SD
LMDHRS	3.98	.30	3.98	.32
GROUPSIZE	1.73	1.18	1.81	1.46
SIZESQ	4.39	7.13	5.41	10.81
NURSHRS	25.36	30.28	37.20	44.96
OTEMPHR	57.72	43.80	57.20	45.80
EMHRSQ	10191.49	19498.99	14376.90	26023.55
LSUPPLIES	6.87	2.01	7.07	2.22
LHOSSIZE	5.62	.62	5.83	.62
LHEMP/SMD	1.80	.49	1.81	.56
IR/SMD	.07	.16	.19	.97
YRGRAD	22.52	12.89	25.50	13.51
YRGRADSQ	672.81	826.06	832.45	897.47
BCDUM	.65	.48	.58	.49
PUBLIC	.14	.34	.11	.31
APPOINTS	1.82	4.67	1.81	4.64
URBAN	.79	.41	.89	.32
MDPOP	.20	.15	.23	.15
LVWOTPT	5.47	.80	4.74	.81
SDUM1	.33	.47	.23	.42
SDUM2	.31	.46	.22	.41
SDUM3			.22	.41

SDUM1=OPHTH
SDUM2=URO

SDUM1=DERMAT
SDUM2=GASTRO
SDUM3=CARDIOV

Specialty Abbreviations:

OEU Ophthalmology, ENT, Urology
ACDG Allergy, Cardiovascular Disease, Dermatology, Gastroenterology

TABLE A2

Means and Standard Deviations of Physician Time and Characteristics, Practice Inputs, and Hospital Inputs and Characteristics by Specialty (Owner-Physicians Data) for the Price Function Regressions

	GP (ALL)		IM (ALL)		PEDS		GS	
SPECIALTY	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
GROUPSIZE	1.39	1.01	1.73	1.42	2.12	1.50	1.69	1.44
SIZESQ	2.96	7.50	5.02	9.85	6.76	10.74	4.91	10.86
PRACWAGEIND	.69	.50	.73	.45	.71	.39	.84	.48
PCTBLACK	18.57	23.80	17.97	22.93	23.27	24.69	20.27	23.07
HOSSIZE	356.39	247.52	421.56	225.03	398.80	226.43	384.24	211.21
OWNLAB	.81	.40	.76	.43	.80	.40	.32	.47
LHEMP/SMD	7.38	3.59	7.12	4.52	6.31	2.96	6.84	3.42
BCDUM	.16	.39	.39	.49	.66	.48	.70	.46
PUBLIC	.13	.34	.08	.27	.09	.29	.07	.25
YRGRAD	26.19	11.65	25.63	13.25	22.54	11.28	27.08	11.33
YRGRADSQ	820.83	674.46	831.79	940.71	634.88	705.10	861.01	772.91
RETWAGES ($THOU.)	5.05	.46	5.17	.48	5.16	.48	5.12	.50
HOSPWAGES	9138.93	1534.43	9781.00	1664.70	9641.99	1619.99	9598.02	1806.23
PCTNOINS	11.63	14.51	6.83	9.97	15.34	18.56	6.86	9.33
PCTMEDAID	14.66	17.83	12.37	15.23	15.19	19.03	13.47	14.21
PCTMECARE	28.56	29.73	42.46	23.33	.99	5.80	31.19	20.34
SMSAHEMP/MD	15.55	6.69	14.32	5.58	14.61	4.83	14.65	4.94
SMSAHOSWAGES ($THOU.)	9.75	2.75	10.39	3.25	9.90	1.46	9.99	3.29
PCTAFDC	5.12	3.45	8.01	11.32	6.08	7.21	6.87	9.15
POPDENS	3358.65	1462.89	3670.33	1737.29	3707.54	1598.90	3604.78	1616.81
PCTFEMHEAD	11.07	1.85	11.67	1.84	11.61	1.87	11.53	1.92
PCTMOVED	52.28	7.71	51.78	7.42	52.39	7.25	51.74	7.51
MD/POP	.0005	.0002	.0006	.0002	.0005	.0002	.0004	.0001
MD/SQMILE	1.77	.97	2.13	1.21	2.02	1.07	1.41	.64
MFAMINC	10257.76	1287.12	10647.34	1196.22	10562.60	1247.00	10295.11	1370.50
SMSAPCTOVER65	.09	.03	.10	.03	.09	.02	.09	.03
OFFICEFEE	11.60	3.09	15.99	4.95	12.25	3.31	11.19	7.71
HOSPFEE	13.90	6.27	18.01	7.64	15.37	6.47	11.39	10.78

(continued)

TABLE A2 (Continued)

SPECIALTY	OBG		NEURORTH		OEU		ACDG	
	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
GROUPSIZE	2.21	1.54	2.25	1.70	1.73	1.22	1.79	1.42
SIZESQ	7.25	11.15	7.95	11.87	4.47	7.61	5.20	9.82
PRACWAGEIND	.81	.51	.90	.53	.84	.52	.79	.48
PCTBLACK	22.17	23.50	25.02	21.30	20.22	22.90	15.62	18.39
HOSSIZE	403.99	220.92	409.68	233.78	379.94	213.00	426.02	227.58
OWNLAB	.69	.46	.06	.24	.32	.47	.40	.49
LHEMP/SMD	7.24	5.50	6.88	3.11	6.46	2.96	8.26	26.11
BCDUM	.63	.48	.73	.44	.68	.47	.60	.49
PUBLIC	.11	.31	.09	.29	.10	.30	.09	.28
YRGRAD	23.35	10.38	21.17	8.96	23.47	12.65	25.68	13.86
YRGRADSQ	652.50	602.48	528.17	445.14	709.88	799.04	850.89	926.74
RETWAGES ($THOU)	5.12	.46	5.13	.52	5.11	.48	5.15	.48
HOSPWAGES	9547.31	1839.89	9475.81	1728.47	9553.56	1894.37	9928.35	1895.64
PCTNOINS	11.06	11.51	7.07	7.60	9.25	12.38	10.60	15.05
PCTMEDAID	9.87	13.36	12.51	11.09	14.87	15.39	9.89	12.73
PCTMECARE	7.78	12.62	25.53	17.52	36.40	23.99	30.27	23.13
SMSAHEMP/MD	15.06	4.13	13.84	4.95	14.64	5.12	14.31	6.18
SMSAHOSWAGES ($THOU)	10.03	2.93	9.57	1.77	9.76	2.44	10.05	2.18
PCTAFDC	6.22	6.97	6.31	6.85	6.89	9.54	7.41	10.57
POPDENS	3662.17	1589.32	3349.76	1374.99	3500.74	1598.36	3563.88	1680.71
PCTFEMHEAD	11.58	1.84	11.29	1.92	11.38	1.96	11.57	1.76
PCTMOVED	51.54	7.34	53.69	7.48	52.99	7.63	52.53	8.24
MD/POP	.0004	.0001	.0004	.0001	.0005	.0002	.0006	.0002
MD/SQMILE	1.42	.66	1.39	.69	1.95	1.07	2.06	1.13
MFAMINC	10462.88	1276.53	10226.56	1458.71	10313.88	1317.80	10505.69	1328.94
SMSAPCTOVER65	.10	.03	.10	.04	.09	.03	.10	.03
OFFICEFEE	14.56	8.33	16.96	7.67	14.03	6.98	15.08	6.46
HOSPFEE	8.80	10.41	15.26	9.77	10.45	9.48	15.59	8.76
SDUM1			.54	.50	.35	.48	.22	.42
SDUM2					.30	.46	.23	.42
SDUM3							.21	.41

Specialty Abbreviations:

NEURORTH Neurosurgery and Orthopedics
OEU Ophthalmology, ENT, Urology
ACDG Allergy, Cardiovascular Disease, Dermatology, Gastroenterology

SDUM1=NEUROS

SDUM1=OPHTH
SDUM2=URO

SDUM1=DERMAT
SDUM2=GASTRO
SDUM3=CARDIOV

Technical Note B
Definition of Variables

Q_D^i	Vector of services demanded from physician i
P_M	Vector of user prices for physicians' services
P_H	Vector of user prices for hospital services
X	Vector of other demand parameters
$\hat{P}$	Gross price charged
NINS	Fraction of gross price not covered by insurance
M	Vector of physician time input
L	Vector of non-physician inputs hired by physician
H	Vector of hospital inputs
Z	Vector of practice characteristics
C_L	Vector of prices for labor inputs
C_M	Constant cost of physician input
C_H	Vector of prices for hospital inputs
$\hat{P}_T$	Sum of user prices
APPOINTS	Number of staff appointments per patient care physician in market area
BCDUM	Board certification dummy
EMHRSQ	Square of sum of all employee hours
GROUPSIZE	Full-time equivalent physicians as a measure of practice size
HEMP/SMD	Total number of full-time-equivalent hospital employees per staff MD
HOSPWAGES	Annual payroll expenses per employee at hospital used by physician
HOSPFEE	Physician's hospital visit fee
HOSSIZE	Hospital bed size
HOSVIS	Visits to inpatient plus patients seen in hospital clinics or emergency rooms
IR/SMD	Number of interns and residents per staff MD
MDHRS	Physician time either in total or as assigned to various activities
MDPOP	Number of patient care physicians *per capita*
MD/SQMILE	Physician density per square mile in city in urban area
MFAMINC	Median family income in market area
NURSHRS	Time input of medical aides
OFFICEFEE	Physician's office visit fee
OFFVIS	Office visits plus 2x (home visits + nursing home visits)
OPERNS	Operations performed
OTEMPHR	Time input of non-medical aides
OWNLAB	Presence of lab in physician's office
PCTAFDC	Percent SMSA population on AFDC
PCTBLACK	Percent black population in market area
PCTFEMHEAD	Percent of female headed households
PCTMECARE	Percent of particular physician's patients with Medicare
PCTMEDAID	Percent of particular physician's patients with Medicaid
PCTMOVED	Percent of population which has moved in last five years
PCTNOINS	Percent of particular physician's patients with no insurance
POPDENS	Population density in the urbanized area of the SMSA
PRACWAGEIND	Wage rates paid to practice employees
PUBLIC	Government-owned versus non-profit hospital dummy
RETWAGES	Wage rate for retail employees
SDUM	Dummy for specialty
SMSAHEMP/MD	Hospital personnel per patient care physician in metropolitan area
SMSAHOSWAGES	Level of payroll expenses per full-time employee at metropolitan area hospitals
SMSAPCTOVER 65	Percent of population over 65 in SMSA
SUPPLIES	Total amount spent for medical supplies
URBAN	Urban location dummy
VWOTPT	Value-weighted total output, measured by a weighted sum of patient visits and operations
YRGRAD	Number of years since graduation

Comments

by Zachary Dyckman, Ph.D., Peat, Marwick, Mitchell

I am particularly glad to be here today to discuss the Medicare Economic Index, as I initially developed the Index under Mr. Howard West, while we were both at the Social Security Administration. I would like to talk about the background of the Index and then present some comments on Robert Berry's and Mark Pauly's papers.

I recall being a bit uneasy about developing the Index, because we did not use outside consultants at that time. This meant that when you finished a project, only a few people examined it before it was implemented. One of our primary concerns in constructing the Index relates to Bob Berry's paper; that is, the Index was national in scope and did not reflect local price changes or local weights. There was little we could do about this problem because we did not have the necessary data. In fact, we still use a national index today, although more localized weights and speciality-based weights are being considered.

Another concern we had was what we called double-counting of productivity. Originally, a panel of experts working for the Senate Finance Committee helped develop a structure for the Index. As I recall, the structure that they developed gave the physician credit for his or her own productivity increases plus productivity increases that occurred in the entire private sector. In order not to double-count productivity, we had to net out the latter productivity factor from the calculation of the Index.

A further concern was the impact of the Medicare Index on physicians' assignment rates. If the Index was tight, assignment rates would go down, physicians' billed charges would continue to rise, and, although the HHS budget would not have been adversely affected, the Medicare beneficiaries who had to pay for the physician's care would be adversely affected.

Concerning Berry's paper, it appears methodologically sound. I was most interested in the first section, which developed hypothetical Medicare indices based on region, specialty, type of practice, and city size, using the 1975 and 1976 Surveys. These indices are important because, from a policy perspective, we must ask how much of a difference does using a single Index make. By projecting from his 1976 and 1977 hypothetical indices, which use specialty specific weights, to 1981 and 1982, Berry shows that there is little difference between specialty-specific indices and a single index. For instance, the index for all specialties in 1981, using the 1976 price changes, would be 1.37. For internal medicine it would be 1.32; family medical practice, 1.34, and surgery and surgery specialists, 1.42. In other words, surgeons are hurt the most by using an index for all physicians. And this is understandable when you realize what the source of the variability is. As we know, if you do not have variability in rates of inflation, the fact that the specialty cost weights may be incorrect does not matter; as long as the price changes are the same, the overall index will be the same, regardless of the size of the weights used.

The component that increased most rapidly in 1975 was malpractice insurance rates. Since this component affected the surgical specialties much more than the others, by denying these specialties a unique index, they are adversely affected. If we look at price changes during 1977, when the malpractice insurance prices moderated, there is virtually no difference at all between the all-specialty index and the individual-specialty indices. The all-specialty index is 1.32; for internal medicine 1.31, for general family practice 1.32, and for surgery, only 1.33. Unless malpractice insurance rates resume their rapid increase, using one index for all specialties versus an index for the different specialty groups would have little effect.

One comment on this procedure. I think there was some bias toward obtaining only a small difference between the specialty indices and the all-specialty index because the component weights were assumed not to have changed between the 1976 and 1981 period. If, in fact, malpractice insurance rates do rise rapidly, as they did in 1975, then the malpractice weight in 1980 or 1981 would also increase, causing the surgical index to be higher than projected.

In addressing briefly the policy issue of whether we should have indices based on region, specialty, or perhaps type of practice, or use the single index for all physicians. I think we should probably continue with the single index. First, it does not seem to make very much of a difference unless perhaps malpractice insurance rates show very significant rises. And, more importantly, if we do go to a specialty index and the Medicare index for surgery is indeed higher, it would result in higher fees for surgeons and lower ones for GPs and internists. It could also possibly result in higher fees and, therefore, greater concentration of physicians in large, municipal areas and lower fees and fewer physicians in rural areas. This trend is not desirable. So I would just suggest that we be very cautious in going to specialty-based indices.

Concerning Mark Pauly's paper, I think his hypotheses are interesting and innovative. However, one does not have great assurance that they are based on the empirical results. One interesting finding is the positive correlation between hospital inputs and what he calls value-weighted total output as some measure of gross revenue. One could argue that the direction of causation is opposite; rather than hospital inputs allowing physicians to be more productive and to make more money or higher gross revenue, it could be that hospitals have expanded their staffs in response to greater needs for services. Another intuitively plausible hypothesis was tested elsewhere by Pauly and Satterthwaite. If a high density of physicians exists in an area, consumer information regarding any one physician tends to be poor, and, therefore, the markets are expected to be somewhat less competitive, causing higher prices.

I would not put much faith in the testing of the price equations, especially the last finding that lower prices tend to be associated with higher physician input. His empirical results are consistent with several hypotheses and, because of data problems, I do not think he has proven his hypothesis. However, it was an interesting paper.

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Comments

by Mark Hornbrook, Ph.D., National Center for Health Services Research

An important policy issue in these inflationary times is whether physicians are prescribing an inordinate number of "unnecessary" services, where the term "unnecessary" refers to both production and allocative inefficiency. Are physicians wasteful in producing a given output, are they producing the wrong output altogether, or both? Are patients being hospitalized when care of equal quality can be provided at a lower cost on an ambulatory basis? Are patients being admitted for diagnostic work-ups to avoid the hassle of scheduling tests on an ambulatory basis? Are sophisticated diagnostic tests and extensive work-ups being prescribed when a simple "wait-and-see" strategy would be just as effective, with little change in net risk to the patient? Is a surgical mode of treatment adopted when a less invasive, less costly, medical mode would be equally effective? Obtaining answers to these questions requires, among other things, that we understand the determinants of physicians' use of the hospital.

The paper by Mark Pauly represents a significant contribution to the literature in this area. His study examines the impact of the availability and cost of hospital services on physician productivity and fees. His findings suggest that the greater the quantity of hospital inputs available to the physician (as measured by the ratio of hospital employees to staff physicians), the greater the output of the physician and the lower his or her fees, holding constant own time and practice inputs. However, one must exercise caution in interpreting the estimated relations and in deriving specific policy implications. My purpose here is not to cast aspersions on Pauly's work, for it is an innovative piece, but rather to stimulate further work in this area. There is a tendency to believe that when someone with Pauly's credentials looks at an issue, he provides the final answer. Even with his creative theorizing, Pauly is not able to overcome all of the deficiencies in his data.

Pauly defines the output of the physician to be *services,* measured in terms of office visits, hospital visits, and operations. The physician is assumed to be facing a demand curve defined over these specific services. This implies that either the patient has preferences over the various components of the treatment package or the physician has split into two people—a perfect agent for the patient and a supplier of services to that patient. This theoretical enigma is important here only in the sense that the focus on specific services as the relevant output ignores the issue of how these services are combined into treatments, which is one critical source of policy concern. A basic problem with the "service" as the unit of output is that it can lead to inappropriate conclusions regarding productivity and efficiency. As an example, let us assume that two patients, identical in every respect, visit two different physicians. One physician runs his own laboratory and owns an X-ray machine. He prescribes two X-rays and three lab tests which are performed and evaluated during the course of the visit. Output in this case equals one office visit, according to the measurement procedures used by Pauly. Suppose that the second physician prescribes the same work-up for the second patient, but that the patient must go to the outpatient department in a nearby hospital to obtain the lab tests and X-rays. Afterwards, the patient returns to the physician for evaluation of the test results and further consultation. Output in this case is counted as two visits, although the same episode of care is provided to both patients. (Indeed, one could argue that the second physician actually produced care of *lower* quality, considering the delay and inconvenience experienced by his patient.) While this is a hypothetical example, it is presented to illustrate that the *treatment* is a more appropriate definition of the final output of the physician. Furthermore, if the production of specific services, such as office visits, surgical procedures, and so on, is to be investigated, it is important that that vector of services be homogeneous in each component. In the example presented above, the two physicians appear to differ in their production of an intermediate product—number of visits—but this difference would disappear if we accounted for the greater content of the visit produced by the first physician.

Another important dimension of the output of the physician is the diagnosis being treated. I contend that the case-mix of the physician's practice is an important dimension of the output, regardless of whether the resource requirements differ. That is, at a given time two different diseases may require exactly the same treatment processes to produce a successful outcome, so that from an economic perspective, they could be grouped as a homogeneous output. However, the rate of technological change may differ across the two conditions, or physician responses to a given policy initiative may differ across them, resulting in different input bundles for the two conditions. Thus, two physicians with identical office facilities and staff and access to identical sets of hospital services can have very different outputs if the diagnostic mix of their patients is very different. On the surface, it would appear that the physician can spend his or her time treating more patients who have less severe/complex diseases or fewer patients who have more severe/complex diseases, resulting in the same aggregate output of services and surgical procedures. However, this assumes that the nature and content of each visit and operation are measured carefully, and that we are not concerned with allocational efficiency. Regarding the latter, it is possible to conceive of two physicians who are equally efficient in producing treatments, but one treats only in-grown toenails. While it is nearly impossible to value different case types, other than by their costs, we do have social preferences concerning who "needs" care and who does not; we must be very careful in drawing conclusions based on analyses of intermediate products.

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In Pauly's study, visits are measured only by place—office, home, hospital, nursing home, and so on, while procedures are measured by total volume of operations. To the extent that the content of these visits and procedures is correlated with other variables included in the model, specification bias arises. Although this problem is noted by Pauly, he makes no further comment on it. It would seem reasonable to assume that case-mix severity is associated with the staffing levels in the hospital—more severely ill patients require more intensive nursing care, more special therapies, more diagnostic work-ups, and more surgery. The complementary relation observed between hospital inputs and physician services would then be a function of case-mix severity, which is omitted from the model. The reason for this omission is obvious: such data are exceedingly costly and difficult to obtain. In any case, the regression results do not tell us whether physician output and fees would respond if more hospital inputs were provided to the physician for the *same set of patients*. One can argue that hospital size, number of interns and residents per staff physician, personnel per bed, board certification, and so on are capturing any case-mix variation. While the correlation may be high, it is not unity, and omission of case-mix causes us to overlook an important source of inefficiency. Moreover, the model is not appropriately specified for policy purposes: case-mix is endogenous, and this should be reflected in any model used to formulate or evaluate policy measures.

For any given type of case, there exists a production function describing the various treatments that can be expected to provide a successful outcome to the illness episode. It would seem that the more relevant policy issue is that of *substitution,* not complementarity: What degree of latitude does the physician exercise in prescribing care for a given illness? What affects the choice, say, of one more day in the hospital versus a follow-up office visit? My point here is that we need to go beyond Pauly's aggregate analysis to studies of diagnostic-specific utilization patterns for the entire illness episode.

One important assumption in Pauly's model is stated in the first page of his paper: "Insofar as patients pay part of the bill, a high hospital charge can affect what the physician is able to get for his or her own services." While there is nothing wrong with this assumption in and of itself, the logical application of it, in the sense that physicians must accept the "residual" left after the hospital bill has been paid, leads to an uneasy feeling. In the case where hospital and physician inputs are complements and used in fixed proportions, Pauly shows what happens if the level of hospital inputs is increased. The marginal cost of physicians' services drops, due to the physician's increased productivity which, in turn, causes the price of physicians' services to drop and output to rise. However, hospital prices rise to cover the costs of the increased inputs, and the demand for physicians' services shifts to the left. This causes price to drop still further but now *restricts* the quantity of physicians' services. The positive association between hospital inputs and physician outputs is very much dependent upon the range in which you are operating. In his graphic presentation, Pauly shows the new equilibrium to be at a higher quantity of output and lower price than the original equilibrium, which appears plausible and appears to support his main hypothesis. However, suppose hospital costs rose sufficiently to cause a reduction in *both* price and output so that physician incomes were reduced (which appears to be a logical possibility under this model). This could arise when hospital costs rise without any impact on physicians' productivity. This does not mesh with what we actually observe happening with hospital costs and physician incomes. Pauly's model was not developed to explain long-run dynamics, I realize, but the issue remains: do we really believe that the physician-hospital market is structured in such a way that hospitals can take away physician incomes? Or more appropriately, would profit-maximizing physicians allow hospital costs to rise, for whatever reason, to the point of threatening their well-being? Physicians do have substitution possibilities, so that the assumption of complementarity is unduly restrictive. Note that the regression results for the fee equations are much more ambiguous than those for the output equations. It would seem that if anyone is a "residual" taker, it would be the hospital, not the physician.

It is also interesting to note that if the demand curves in Pauly's model are relatively less sensitive to price, as would be the case for very severe illness, changes in physician productivity have less of an effect on the output of services, although fees will still decline. This, in and of itself, suggests that services should be disaggregated according to type of illness because more discretionary types of illness with, presumably, more price-sensitive demands, should show greater responsiveness of physician productivity to changes in hospital inputs.

Pauly suggests that physicians may equip and staff their offices to compensate for the absence of facilities at the hospital. This is troublesome because it would seem that in a geographic area with a shortage of lab and X-ray facilities, the first place where capacity would be added would be at the hospital. Physicians must react to this shortage factor, to be sure, but it would appear that they would cut down on use of routine screening and preventive procedures, so that the more important effect would be on the case-mix of the hospital facilities, rather than on the case-mix of the physicians' offices.

In addition to the results stressed by Pauly, his production function estimates reveal some other interesting findings:

1. The elasticity of physician output with respect to physician time is less than one for all specialties except general surgery and obstetrics and gynecology. It is interesting to consider that the marginal productivity of physician time in these two specialties might be increasing, so that costs are decreasing. These are

specialties that have been viewed as being in excess supply and as being characterized by induced demand. The coefficients on these variables should be tested to determine if they are significantly different than one.

2. Group size is significant only for two specialty groups—obstetrics and gynecology and neurosurgery and orthopedics. In the case of OB-GYN, the results imply that the maximum output is obtained with approximately four physicians in the group. The mean group size for this specialty for the sample is approximately two and one-fifth physicians. For neurosurgery and orthopedics, the optimum occurs at 6.1 physicians, while the actual is 2.25. These results suggest that further research is needed to determine if these specialties could really benefit from reorganization into larger groups.

3. The public hospital dummy variable shows some very interesting findings. Internists, allergists, cardiologists, dermatologists, and gastroenterologists tend to have lower output when associated with a public hospital, while surgeons tend to have higher outputs in these hospitals. Does this imply that public hospitals tend to be dominated by surgeons, specialize in surgical case-types, and prefer a surgical mode of treatment? This is an issue certainly worthy of further investigation.

4. Urban general practitioners tend to have less output than rural general practitioners. Is this a case-mix effect, a discrimination effect, or both? That is, do rural physicians treat a wider range of illnesses by virtue of the lower supply of physicians in those areas, are they discriminated against in terms of admitting and surgical privileges in urban hospitals, which tend to be controlled by specialists, or both?

5. Surgeons in physician-rich areas tend to have less output than in physician-poor areas, which suggest that they are not as successful in manipulating demand as some have hypothesized. Again, this is consonant with the interpretation of excess capacity of the hours worked variable.

6. Board certification increases output, where statistically significant, except in the case of OB-GYNs, who work regular hours. The latter may be a practice maturation effect.

7. It seems strange that the presence of interns and residents does not appear to markedly increase physicians' output in most cases. One empirical issue is what types of training programs were represented in the sample. A surgical residency program would have little effect on the internists in the hospital. It would be interesting to look at the various specialty equations with the number of interns and residents in the given specialty included in the equation, instead of the hospital-wide number. It would also be appropriate to include a measure of the teaching output of the physician on the left hand side, to the extent that this is feasible.

8. The regression results for the fee equations are much more difficult to interpret due to the presence of multicollinearity. One relatively stable result is that physicians who have their own labs tend to charge less for follow-up office and hospital visits. It would be relevant to know whether this is a result of competition in the market or of regulatory controls on physician reimbursement.

9. Board certification has a positive association with the office visit fees of pediatricians but a negative association with the hospital visit fees of neurosurgeons and orthopedic surgeons.

10. Hospital visit fees for general practitioners and OB-GYNs in public hospitals tend to be higher and lower, respectively, than for physicians with appointments in other types of hospitals.

The policy conclusion drawn by Pauly is that assessment of rises in costs of practice inputs is not sufficient to regulate reimbursement to physicians, because changes in the availability of hospital-based inputs will also affect the physician's pattern of practice and resultant income. Whether or not you agree with how he got here, Pauly's conclusion certainly has an intuitive appeal.

His conclusion regarding the counterproductivity of certificate of need (CON) efforts needs to be qualified somewhat. The technology of hospital care may be shifting faster than we are closing down beds. There has been a downward trend in length of stay and occupancy rates in U.S. short-term general hospitals over the past few years. The net effect on the supply of hospital services between this technology shift and the CON efforts is not clear.

In conclusion, the next step is to create a data base for a sample of physician practices which, in addition to the types of variables included in this study, contains information on diagnoses and the specific services provided to patients, on both an inpatient and outpatient basis, over the course of the illness. This will give us a much better picture of how and why the physician uses the hospital.

Physicians and Blue Shield: A Study of Effects of Physician Control on Blue Shield Reimbursements

by Frank A. Sloan

This study assesses the impacts of specific Blue Shield-organized medicine relationships to levels of reimbursement for various medical and surgical procedures and on physician willingness to participate in Blue Shield service benefits programs. The empirical analysis shows that Blue Shield reimbursements and participation rates are higher when doctors have formal roles in plan decision-making. The results on participation, in combination with evidence from previous research, establish a link from control to higher Blue Shield reimbursements to greater physician willingness to accept Blue Shield patients on a payment-in-full basis. Results also indicate reductions in care to persons eligible for public program support, in particular Medicaid.

The dependent variables in this analysis are Blue Shield payments for several specific medical services (data obtained from MD respondents) and a binary variable indicating respondent participation in Blue Shield. Explanatory variables consist of (1) characteristics of Blue Shield plans, including those indicative of physician control; (2) variables related to consumer insurance coverage; (3) variables related to determinants of the physician supply curve facing Blue Shield; and (4) variables describing individual physician characteristics.

The coefficient of the physician control variable is statistically significant at the 5 percent level in four of the six regressions. These findings suggest that physician control of Blue Shield boards does tend to exert a positive influence on payment levels, but that this influence is not consistent across specialties. In particular, surgeons tend to benefit less from physician control than non-surgeons.

As in the case of the payment level regressions, physician control of Blue Shield variables was a consistently important determinant of physician participation in Blue Shield. Physicians practicing in areas where medical societies make appointments to Blue Shield boards are more likely to participate.

Introduction

Increasingly, actions by a variety of occupational groups that were once justified as ways of protecting the public interest are now held to be ways of furthering the financial interests of the occupations themselves. Professional fields, such as law, medicine, and optometry, which until recently enjoyed *de facto* exemptions from U.S. antitrust laws, have come under considerable scrutiny from both legislative and judicial branches of government in the 1970s. Unfortunately, much of the evidence furnished by the prosecution in cases involving these professional groups has related to structure or process rather than to market outcomes.

In the context of physicians' relations with Blue Shield, evidence of the structure-process variety encompasses physician participation on Blue Shield boards, organized medicine's role in the selection of Blue Shield boards, and various statements in letters and in Blue Shield brochures indicating a physician-Blue Shield connection. Outcome-specific measures refer to Blue Shield payments to physicians for specific procedures, quantities of services rendered to Blue Shield

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subscribers, and the like. Evidence linking structure-process to outcomes merits far more weight in antitrust inquiries than structure and process alone. (Scherer, 1970; Kahn, 1970; Posner, 1976). But such evidence has generally been lacking in antitrust inquiries in medical care markets.

In 1976, 75 percent of outlays on personal health care were financed by third parties (Health Insurance Institute, 1978-79). Blue Cross-Blue Shield are by far the largest single private insurers; in 1975, they had about half of the private insurance business in the U.S. (Health Insurance Institute, 1978-79).[1] While it is incorrect to characterize Blue Cross or Blue Shield as national non-profit insurance firms, since local Blue Cross and Blue Shield plans have considerable autonomy, the Blues have the largest market share of any single insurer in the vast majority of States.

Any major public policy action designed to foster competition in the medical marketplace via health insurers would almost inevitably involve rule-making and changes in the health insurance regulatory apparatus. Such changes are not without cost. Not only could various new rules impose costs on insurers, but, more importantly, given the absence of empirical evidence on how existing relationships between insurers and health care providers affect market performance, policy actions in this sphere could easily be misplaced. Policymakers could conceivably lose valuable time "barking up the wrong tree."

This study assesses the impacts of specific Blue Shield-organized medicine relationships to levels of reimbursement for various medical and surgical procedures and on physician willingness to participate in Blue Shield service benefit programs. The empirical analysis shows that Blue Shield reimbursements and participation rates are higher when doctors have formal roles in plan decision-making. The results on participation, in combination with evidence from previous research, establish a link from control to higher Blue Shield reimbursements to greater physician willingness to accept Blue Shield patients on a payment-in-full basis. They also indicate reductions in care to persons eligible for public program support, in particular Medicaid. Impacts on physicians' fees, though not documented empirically, are quite likely. Certainly a strong theoretical case can be made for such impacts.

The next section presents pertinent background information. This is followed by the theoretical framework, description of data, and empirical specification. Results and implications from the empirical analysis are found in the final two sections.

[1]The estimate of market share is based on benefit payments data.

Background

There is a clear historical connection between Blue Shield plans and State and local medical societies. There is an equally clear link between Blue Cross and State-local hospital associations. In 1939, the California Medical Association and the Michigan State Medical Society were instrumental in organizing the first Blue Shield plans. At the outset, Blue Shield plans in these States and elsewhere were controlled by physicians. The local medical society often advanced the initial capital for a plan (Reed, 1947). At the same time, individual doctors "underwrote" plans by agreeing to treat Blue Shield subscribers, especially those with low incomes, for amounts less than their "usual" fees. State Blue Cross-Blue Shield enabling acts, which give the Blues both non-profit status and some tax advantages over the commercials (Frech, 1974), have often required that plans be subject to medical society approval or that a majority of the board of directors be physicians (Reed, 1947; Somers and Somers, 1961). The importance of the tax advantages has been debated, but not yet settled.[2]

Until recently, when such statements have become both politically and legally sensitive, documents from physician organizations and Blue Shield plans often referred to the plans as the "economic arm of the profession"[3] or, in a more altruistic vein, as "the doctor's plan—*for the people*."[4] Instances of anticompetitive practices by Blue Shield and organized medicine, such as boycotts of cost-conscious insurers and individual physicians engaged in price-cutting activities, have been documented.[5] Moreover, potential punitive actions may be sufficient to deter competition on the basis of price.

Two other key features have characterized Blue Shield plans throughout much of their history: service benefits and community (as opposed to experience) rating. Only the first of these is directly pertinent here.[6] Under a service benefit

[2]See Frech and Ginsburg (1978) and Berman's (1978) reply.

[3]See Federal Trade Commission (1979), pp. 1-2 for documentation.

[4]Unpublished Blue Shield brochure. Emphasis is Blue Shield's.

[5]Goldberg and Greenberg (1978) describe the origins of the Oregon Physicians' Service, the forerunner of Blue Shield in Oregon, a prepayment plan organized by physicians as a means of (successfully) driving out other insurers from that State. Also see Reed (1947), Kessel (1958), Federal Trade Commission (1979), and Thompson (1979).

[6]A more detailed description of the service benefit concept is presented by Sloan and Steinwald (1975, 1978).

plan, the insurer promises covered patients a bundle of "free" services (zero copayment for specific services rendered); the physician accepts the insurer's reimbursement as payment-in-full and collects his or her payment directly from the insurer. Alternatively, under indemnity plans typically used by commercial insurers and sometimes by Blues as a "competitive response" to the commercials, the insurer pays a fixed amount for a specific procedure. The physician may (and frequently does) bill the patient for charges in excess of the third party payment. As a rule, under indemnity, the patient is responsbile for collecting from the third party. All physicians need do is complete a form describing services rendered.

Agreements by physicians to participate in Blue Shield service benefit programs roughly fall into two categories: those in which individual physicians themselves decide their participation status and those in which the participation decision is made collectively, that is, by agreement of the physician's medical society. Individual agreements are about three times as numerous as medical society endorsements (unpublished correspondence with Blue Shield Association). When individual physicians have the option of participating, a recent study indicates that 28 percent of office-based physicians declined to do so (Sloan and Steinwald, 1978).[7]

Analytically, a number of alternative models could depict ties between the plans and doctors. The notion that at least some Blue Shield plans could be characterized as producers' cooperatives was advanced by Louis Reed in 1947. In contrast, there is evidence of some controversy between Blues and medical care providers, and some plans may conceivably reap monopsony[8] profits by "exploiting" physicians. (See, for example, *American Medical News,* 1977; Anderson, 1975; Enright, 1978; Rosencrans, 1979; Sheridan, 1977.) The latter view is admittedly incomplete, given the plans' non-profit status. Possibly a non-profit monopsonist spends its profits on perquisites to management, as Blair *et al* (1975) have suggested. Or perhaps profits are spent promoting the Blue Shield philosophy. Still another model postulates a bilateral monopoly, with Blue Shield and organized medicine on opposite sides.

Analytic Framework

Several models may be appropriate for analyzing price and output behavior of Blue Shield plans; for each, I assume that Blue Shield sells a single product, a full coverage health insurance policy. As an intermediary, the plan performs two functions. First, it enrolls families, and second, it contracts with physicians to provide services to Blue Shield on a payment-in-full basis. By deciding on the number of families to enroll and the quantity of services to purchase from physicians, the plan determines services per enrollee or, equivalently, the quality of its product.

Assume the Blue Shield plan faces the following hedonic premium function:

(1) $p = p(r;\alpha)$, where
p = premium

r = quantity of services provided on a payment-in-full basis (q) divided by number of enrollees (e)

α = any exogenous demand factor accounting for vertical shifts in $p(\cdot)$.

As specified in (1), the plan is a price-taker in its product market, a simplifying assumption with no qualitative effects on predictions. With a higher ratio of services to enrollees, the plan can charge a higher premium ($p_r > 0$). Even as specified, $p(\cdot)$ is downward-sloping in e, in that, holding q constant, the plan has to lower p as it adds enrollees. Exogenous demand factors which vary among areas, such as community income *per capita*, educational attainment, family structure, urbanization, and unionization, affect the amount of premium paid for a given level of quality.[9]

Further assume, in any community, that there is an upward supply curve relating the quantity of services physicians are willing to supply to Blue Shield on a payment-in-full basis to the payment they receive per unit of physician output (g).

(2) $g = g(x;\gamma)$, where
g = fee schedule
x = quantity of physicians' services sold to plan
γ = any exogenous factor shifting the supply curve.

The supply curve slopes upward for this reason. At low g, only low quality doctors are attracted to the plan; others sell their output elsewhere. As g rises, higher quality doctors agree to treat Blue Shield patients. Examples of variables included in γ are wages paid non-physician personnel and the percentage of doctors in the community with degrees from "third world" countries. Higher wages and a lower third world percentage shift (2) inward.

The production function for the plan is

(3) $q = q(x, z)$, where

q = quantity of services provided Blue Shield enrollees
z = quantity of administrative input, including claims clerks and insurance sales personnel.

[7]Their data are for 1973.

[8]This occurs when one entity exercises a disproportionate influence over the market for an input.

[9]This list reflects empirical research on health insurance by Feldstein (1973), Phelps (1973, 1976), Sloan and Steinwald (1980), and others.

At one extreme, the Blue Shield plan exercises monopsony power over community physicians. Then the plan's profit function is

$$\text{(4)} \qquad \pi = p(r;\alpha)e - g(x;\gamma)x - vz, \text{ where}$$

e = number of families enrolled in plan
v = price of administrative input.

Given (4), the plan determines optimal levels of x,z, and e. Input and enrollment levels in turn determine the quality of Blue Shield policy (r) and the premium (p).

Maximizing π, the first order conditions are

$$\text{(5)} \qquad \pi_x = p_r q_x e - g_x x - g(\cdot) = 0$$

$$\text{(6)} \qquad \pi_z = p_r q_z e - v = 0$$

$$\text{(7)} \qquad \pi_e = p_r r_e e + p(\cdot) = 0$$

Equation (5) gives the profit-maximizing condition for the monopsonist, namely, the quantity of x purchased occurs at the point where the marginal factor cost ($g_x x + g$) equals the marginal revenue product ($p_r q_x e$). The difference from the standard textbook case is that marginal revenue product refers to extra units of product quality rather than quantity. Since the market for z is competitive, equation (6) states that optimal z occurs where the marginal revenue product from expanding quality equals v. According to (7), enrollment is set at the point where selling further policies would lower total plan revenue (marginal revenue = 0).

Collective action by community physicians may offset Blue Shield's monopsony power. Bilateral bargaining models involving a single buyer and seller on an input yield indeterminate predictions. Outcomes depend on three factors: seller preferences, in this case of the local medical society; the relative bargaining power of the buyer and seller; and bargaining strategies pursued by the parties (Cohen and Cyert, 1975; Kreps, Somers, and Perlman, 1974; Malinvaud, 1972). Three bilateral monopsony approaches (not the only ones) are depicted in Figure 1. First, the seller may attempt to maximize the dollar surplus above the reservation price (g).

To accomplish this, the seller sets x at the intersection of a curve marginal to the plan's demand for physician labor curve (MRP') and the physician supply curve (AFC). Using this strategy, the seller attempts to sell x_B for g_B but g_B is unattainable as drawn without bankrupting the plan. This, of course, need not be the case.

A second seller strategy involves bargaining for a higher wage at the monopsonist physician input level x_A. In Figure 1, the doctors would try for g'_B (but as before, would encounter a bankruptcy constraint as drawn, before reaching g'_B). Third, a local medical society interested in spreading Blue Shield monies to a large number of its members might set x at x_C. There, Blue Shield's monopsony power is fully offset.

In contrast to such points as B and B′, C, like A, is located on the supply curve. Given that there is absolutely no evidence that the privilege of participating in a Blue Shield program is limited by local medical societies or anyone else, the equilibrium solutions A and C are much more plausible than B and B′ or any other scenario in which an excess supply of x prevails.

At the other extreme, doctors run Blue Shield as a doctor's cooperative, maximizing the difference between premium income and costs and distributing the residual among themselves. In one case, doctors maximize the difference between $p(\cdot)e$ and vz. Then equilibrium x and g are x_D and g_D. But this solution is implausible, since setting x_D where MRP equals zero, the doctors value their own time at zero.

More plausible are the cooperative sets x and g at the point of intersection between the supply curve and the net average revenue product curve (NARP), where

$$\text{NARP} = [p(r;\alpha)\, e - vz]^{\frac{1}{x}}$$

Then

$$\text{(8)} \qquad L = g(\bullet)x + \lambda[p(\bullet)e - g(\bullet)x - vz]$$

The first order conditions for z and e are identical to the Blue Shield monopsonist case. The derivative $dL/d\lambda$ states that equilibrium occurs at E in Figure 1.

$$\text{(9)} \qquad dL/dx = g_x x + g(\bullet) + \lambda[p_r q_x e - g_x x - g(\bullet)] = 0$$

Since MFC exceeds zero, λ must be positive to satisfy (9). In equilibrium, according to (9), MFC exceeds MRP at E in Figure 1.[10] Input level x_E for the physicians' cooperative exceeds x_A, the physician input level chosen by a Blue Shield monopsonist.

In sum, knowledge of the relevant institutions in combination with theory leads to two implications: First, irrespective of who controls Blue Shield, equilibrium should occur along the community physician supply curve $g(\bullet)$. Second, as physicians gain more control of Blue Shield management, both x and g rise. Hence, an empirical test of the above should show that descriptors of physician control have systematic impacts on both fee schedules and physician inputs. For this reason, regressions with both measures of g and x as dependent variables are specified below.

Comparative statics analysis on the monopsony and physician cooperative equilibrium models yields ambiguous predictions about impacts of changes in α and γ on x and g.[11] However, sources of ambiguity are similar. Therefore

[10] Equation (9) can be rewritten as

$$g_x x + g(\bullet) = (\lambda/1-\lambda)\, p_r q_x e.$$

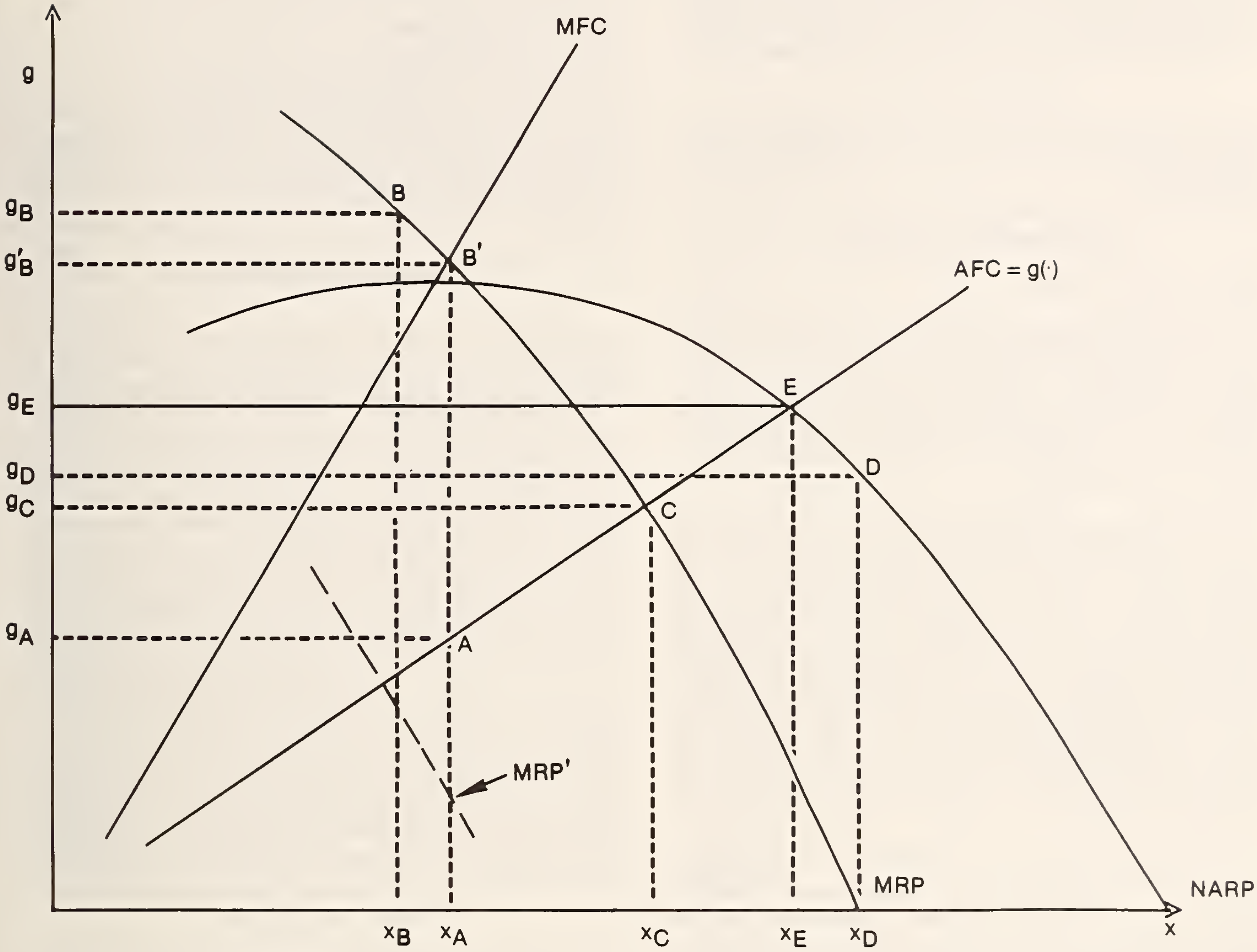
Thus, for (9) to hold,

$$(\lambda/1-\lambda) \geq 0.$$

This only occurs for $0 \leq \lambda < 1$.

[11] The comparative statics are readily derived. For comparative statics on the producer cooperative model, see Domar (1966).

FIGURE 1
Alternative Models of Plan Behavior



there is no reason to believe that the exogenous shift variables should behave in qualitatively different ways depending on who controls Blue Shield.

Finally, a competitive insurance market has been assumed. As is implied in the previous section, there is ample reason to believe that the health insurance market contains important monopolistic elements. As we have just seen, however, even in a competitive product environment with a doctor-controlled plan, x and g rise as the plan offers a higher quality product. Assuming that the Blue Shield plan faces a downward-sloping demand curve for its product would not alter this conclusion.

Data

The core data base for this study comes from both the national and regional samples of the 1975 Physicians' Practice Costs Survey. For this study, I combined both samples, using a weighting algorithm designed by the National Opinion Research Center (NORC) to eliminate overrepresentation of the two regional survey census divisions and to arrive at the appropriate number of effective degrees of freedom (which is always considerably less than 2,024). Primary Sampling Units (PSUs) correspond to Standard Metropolitan Statistical Areas in the case of metropolitan areas and counties or clusters of counties in the case of nonmetropolitan areas.

Since one can identify the physician's county, corresponding area data were merged with the 1975 survey when possible. Data on Blue Shield characteristics correspond to the Blue Shield plan area in which the physician practices. The

1975 survey includes physician respondents from 27 of the 69 Blue Shield plans. The 27 are considerably larger than average; although my empirical analysis includes only 39 percent of the plans, those included encompass 69 percent of the U.S. population. In measures of physician control, the 27 are precisely comparable to the 69 plans on some criteria (for example, medical society approval of the plan) and somewhat less subject to physician involvement on others.[12] In one instance (union coverage), I had to use State data.

Finally, biographical data on survey respondents from the American Medical Association were merged with the 1975 data. The individual physician is the observational unit in all regressions.

Empirical Specification

Dependent Variables

Empirical counterparts of g and x in the following reduced form regressions are measures of the amount Blue Shield pays the physician for specific procedures under its most generous reimbursement program and a binary variable that equals one if the physician participates in the Blue Shield service benefit program.[13]

Blue Shield payment data are available for follow-up hospital and office visits, hernia repairs, diagnostic D and Cs, complete blood counts, and electrocardiograms.[14]. If the Blue Shield plan paid the doctor different amounts for a given procedure, the doctor was requested to give amounts reimbursed under the most generous plan. All monetarily-expressed variables in this study, including the measures of g, have been deflated by an area cost-of-living variable.[15] As seen in Health Policy Center (1979), there is substantial intraplan variation in amounts paid individual physicians for specific procedures.

The 1975 survey asked physicians which of the following best described their current participation status: (1) participating and have signed a participation agreement (with the Blue Shield plan); (2) participating on a case-by-case basis; (3) participating on the basis of county or State medical society endorsement; (4) not participating; (5) no patients covered by Blue Shield insurance; (6) service benefit-participation arrangement not available in the physician's area; (7) physician bills at Blue Shield payment rate but has not signed a participation agreement. The dependent participation variable in the regressions presented below is one if the physician gave either the first, third, or seventh responses and is zero if he or she gave either the fourth or sixth responses. Observations in which the physician participated on a case-by-case basis or there were no Blue Shield patients in the locality were eliminated from the participation regression.[16]

Explanatory Variables

Explanatory variables fall into these categories: (1) characteristics of Blue Shield plans; (2) exogenous demand for service benefit insurance variables; (3) exogenous determinants of the physician supply curve facing Blue Shield; and (4) individual physician characteristics.

Blue Shield Characteristics

Based on a reading of individual plans, the Federal Trade Commission (FTC; 1979) classified Blue Shield plans according to the degree of organized medicine's involvement in the selection of Blue Shield boards. The FTC developed four categories: (1) medical involvement in selecting less than 50 percent of the board members; (2) medical involvement in selecting 50 percent or more of board members; (3) self-perpetuating boards in which there is no apparent formal medical society involvement in selection; and (4) plans that fit in none of the above three groups, that is, those with no apparent formal medical society involvement, past or present, in selection. In the "none apparent" group, boards are selected, for example, by corporate members, subscribers, or both. The second group may be expected to rank highest in terms of physician control, followed by the first, third, and fourth. Although self-perpetuating boards do not reflect direct current influences of organized medicine, they may be linked to physicians' groups by appointments made in the past. In my analysis, binary variables BD49, BD51, and BDSP identify the first three groups, with "none apparent" the reference category.[17]

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[12]In 1977, medical societies appointed the majority of board members in 48 percent of the 27 plans; the corresponding percentage for the universe was 61. In the sample of 27, physicians had a supervisory function over all of five major committees in 63 percent of plans; the corresponding percentage for all plans was 75 in 1977.

[13]A continuous measure of x would have been more desirable, but it is not available from any data base for which total practice output is also available. The binary variable is certainly correlated with its continuous "cousin" since, for non-participants, x = 0.

[14]Payments for a simple suture are also available from the survey. This procedure was eliminated from our analysis, however, because NORC reported that physicians found the suture question ambiguous.

[15]Described in Institute of Medicine (1976).

[16]To my knowledge, physicians participate on a case-by-case basis in two States, but some physicians from other States also gave this response. These physicians probably mean that they participate in "partial service benefit" programs. For a description of this arrangement, see Sloan and Steinwald (1978). Unlike the Sloan-Steinwald study, which only includes physicians who made an individual participation decision, the participation dependent variable used here encompasses individual physician *and* collective medical society participation decisions.

[17]See Federal Trade Commission (1979). Data for BD49, BD51, and BDSP come from this source and pertain to 1978. A few recent changes in appointment practices are noted in the FTC source. These changes tend to be minor, for example, a change from BDSP to "none apparent." Nevertheless, I have taken these changes into account in defining the variables. In most instances, the plan bylaws information abstracted by the FTC is for a year prior to 1978 (1970-1977) and still in effect in 1978.

A second dimension of physician control pertains to the occupational composition of Blue Shield boards. All else being equal, a higher percentage of physician board members should be associated with a higher degree of physician control. Even though board composition is conceptually distinct from medical societies' power to make board appointments, in practice, the two are closely related. In only two of the 11 plans[18] in which medical societies appoint a majority of board members were there a minority of physician board members; the correlation between BD51 and the percentage of physicians on boards is 0.84. For this reason, the latter variable has been excluded from the regressions. Parameter estimates on the BD51 variable reflect the influence of board appointment methods and the occupational mix of the board (and perhaps other unspecified dimensions of control as well).

Third, individual Blue Shield plans have special committees, a majority of whose members may be physicians, responsible for some or all of the following five functions: review and modification of fee schedules; review of medical claims requiring individual consideration and establishment of claims administration policy; review of criteria for determination of reasonable charges; adjudication of fees exceeding "usual-customary-reasonable" (UCR) payment criteria; and review, participation or both of utilization review.[19] The binary variable COM is one if physicians have control over all five committee functions. Physicians have control over *some* of the above committees in all plans, but they have a majority in only about two-thirds of them.[20]

Fourth, as of 1977 58 of 69 plans had formal medical society approval. Lack of approval may be indicative of lack of continuing support by organized medicine of the local Blue Shield plan. The binary variable MSOC is one for plans with formal medical society approval.[21]

Demand Shift Variables

Past empirical research suggests a number of potential determinants of consumer demand for complete insurance coverage, empirical counterparts of α. In preliminary regressions, variables representing *per capita* income, unionization, percentages employed in agriculture and manufacturing, and racial minority and female head of household percentages were included as explanatory variables. Many of these had insignificant impacts on the dependent variables. Only three, *per capita* income (Y), agricultural employment as a percentage of total employment (AGR), and union enrollment as a percentage of the non-agricultural workforce (UNION) are retained in the regressions presented below.[22]

Supply Shift Variables

A substantial number of variables (counterparts of γ) may be expected to shift the supply curve $g(\bullet)$. Among these are descriptors of physicians in the area: credentials of physicians, such as specialization, faculty affiliation, type of medical school attended and board certification status; personal characteristics of the physicians systematically related to physicians' time prices; and prices of non-physician inputs. Income (Y), included above, could also shift $g(\bullet)$, since doctors can command higher fees from non-service benefit patients in areas with high Y.[23] Some of these supply variables have been eliminated from consideration because they are only available for the national sample or they proved to have no discernible effect on the dependent variables or were collinear with included explanatory supply variables. Three variables in addition to Y represent the supply component: percentage of physicians in the area who are age 60 years and over (CAGE); percentage of physicians who are graduates of a foreign medical school in a non-English-speaking, non-Western European country (CFMG),[24] and an index of weekly wage rates of non-physician personnel in physicians' practices (WAGE), all defined for the PSU.[25] The 1975 survey collected wage data on all non-physician employees in the practice. For coding purposes, non-physician occupations were grouped into ten occupational categories. Indexes by PSU were constructed using the *national* distribution of personnel in the ten categories as weights.

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[18] Medical societies appointed a majority of board members in more than 11 plans, but only in 11 out of my sample of 27.

[19] Sloan and Steinwald (1975) describe the UCR system.

[20] Data are for 1977; the source is the U.S. House of Representatives (1978).

[21] The source is the U.S. House of Representatives (1978). Another variable one might include is the Blue Shield market share. I have excluded this variable from reduced form equations on grounds that the share is likely to be a result of (rather than a reason for) physician control. The market share was included as an explanatory variable in preliminary regressions; results on the control variables tend to be insensitive to its inclusion or exclusion.

[22] The variable Y, deflated by an area cost-of-living index, is defined for the physician's county; data are from the 1974 Current Population Survey. AGR, also defined for the county, comes from the 1970 U.S. Census of Population. Data for UNION, unfortunately only available by State, come from the U.S. Department of Commerce (1977).

[23] This is what Sloan and Steinwald (1978) found.

[24] An exception is made for graduates of Mexican medical schools, who for purposes of this study are considered domestic graduates.

[25] CAGE and CFMG are based on distributions of respondents to the survey.

Individual Physician Characteristics

Even though a Blue Shield plan's payment, or distribution of payments, for specific procedures is likely to reflect characteristics of physicians in the area, payment levels vary substantially within (as well as between) plan areas. In part, these within-area variations are intentionally designed to reflect differences in physicians' credentials. For example, a plan may explicitly recognize specialty, or the payment may reflect the physicians' usual charges to other patients. To the extent that prestigious credentials are not recognized for reimbursement purposes and non-Blue Shield patients are willing to pay more to physicians with these added qualifications, a lower proportion of the less qualified physicians will be willing to accept Blue Shield payment as payment-in-full. Credentials variables, included in both payment and participation regressions, specified for the individual physician are: SPEC = 1 if the physician is a specialist; BCERT = 1 if the physician is board-certified in a specialty; FAC = 1 if the physician has a medical school faculty appointment; AGE = 1 if the physician is age 60 or more; and FMG = 1 if the physician is a graduate of a foreign medical school in a non-English-speaking, non-Western European country.

Several other exogenous supply variables are available from the national but not the regional 1975 survey: PY = 1 if the physician (and his family) had income, other than from the practice of medicine, amounting to more than $10,000; MAR = 1 for married physicians; HL = 1 if the physician reported that he or she has had to shorten the workweek or change the pace of the practice for health reasons; and CH = number of children ages 18 and under of female physicians.[26] Each of the latter four variables is likely to be positively associated with the physician's shadow wage (for market work). Since these variables are only available from the national survey, the sample is greatly reduced when they are included. For this reason, they appear only in a variant of the participation regression. The sample sizes for the payment level regressions are substantially smaller. To include the latter four variables in these regressions would result in an inadequate sample.[27]

Empirical Results

Nature of Samples

Table 1 presents concise variable definitions and sample means and standard deviations for the combined national-regional sample and for the national sample only. Overall, the two samples are quite similar. As seen in Table 1, half or more of the physicians in our samples practiced in Blue Shield plan areas in which the medical society appointed a majority of members to the board. A majority of sample members practiced in plan areas where physicians controlled all five committees, and a vast majority practiced in areas where the medical society approved the plan. Another notable characteristic of both samples is overrepresentation of physicians age 60 and over.

Blue Shield Payment Regressions

Table 2 contains payment regressions for six procedures. Numbers in parentheses are standard errors; those in brackets are the coefficients as fractions of the means of the dependent variables, in the case of binary explanatory variables. Otherwise (for continuous explanatory variables), they are elasticities evaluated at the observational means. The regressions explain from 15 to 31 percent of the variation in the dependent variables. Judged in terms of statistical significance, the "best" variables pertain to Blue Shield plan characteristics, *per capita* income, and specialty status.

Above, we ranked the medical society board appointment variables from highest degree of control, BD51, to lowest, "none apparent" (the excluded control variable). BD51 is statistically significant at the 5 percent level or better in four of the six payment regressions; in a fifth, the parameter estimate is substantially greater than its standard error. Only in the hernia repair regression is the BD51 coefficient both small and very imprecise. It is noteworthy that even in this case, the simple correlation between BD51 and the hernia payment is highest of all the explanatory variables (+0.22). The insignificant impact is attributable to multicollinearity in a regression based on comparatively few physicians.

Judging from the numbers in brackets, medical society appointment of 50 percent or more of the Blue Shield board raises payment levels relative to the "none apparent" plans on average by 15 and 28 percent for the two visit variables, 17 and 13 percent for the two medical-laboratory variables, and by 4 and 9 percent, respectively, for the two surgical procedure variables. These patterns suggest that surgical specialists may be getting "the short end of the stick" in physician-controlled plans. But far more evidence is needed (for example, on the specialty composition of physicians on boards) before a firm conclusion is warranted on this matter. The pattern does serve to emphasize, however, that all types of physicians may not benefit equally even if, as a group, they have an important, or even dominant, role in plan decision-making.

As anticipated, impacts of BD49 plans, relative to the "none apparent" reference group, tend to be smaller. Payments for visits are 12 percent higher on average. Those for the complete blood count and electrocardiogram are essentially the same as the "none apparent" group.

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[26]Justification for including these variables is presented in Sloan, Cromwell, and Mitchell (1978).

[27]The principal reason for the loss of observations is missing values on the payment dependent variables. In many cases, the physician did not perform the procedure in question. In others, the physician or aides were uncertain about the amounts particular third parties paid.

TABLE I

Concise Variable Definitions, Means, and Standard Deviations

Variable	Definition	Sample Means and Standard Deviations: National-Regional Sample	National Sample
Dependent Variables			
Blue Shield Payments:			
Followup hospital visit[1]		10.77	—
		(3.92)	(—)
Followup office visit fee[1]		8.51	—
		(3.75)	(—)
Inguinal hernia repair[1]		256.33	—
		(64.91)	(—)
Diagnostic D and C[1]		118.65	—
		(39.04)	(—)
Complete blood count[1]		6.60	—
		(3.04)	(—)
Electrocardiogram[1]		17.20	—
		(4.86)	(—)
Participation	yes + 1	0.77	0.78
		(0.42)	(0.41)
Explanatory Variables			
BD49	Medical society appoints less than 50% of board[2]	0.25	0.24
		(0.43)	(0.42)
BD51	Medical society appoints 50% or more of board[2]	0.54	0.50
		(0.49)	(0.50)
BDSP	Board self-perpetuating[2]	0.09	0.05
		(0.27)	(0.23)
COM	Physicians control all five committees[2]	0.65	0.64
		(0.47)	(0.48)
MSOC	Medical society formally approves plan[2]	0.92	0.96
		(0.27)	(0.20)
Y	*Per capita* income[1,3]	4771.	4801.
		(564.)	(533.)
UN	Percent of non-agricultural employees unionized[4]	26.2	—
		(10.6)	(—)
AGR	Percent of total employment in agriculture[3]	4.0	—
		(5.4)	(—)
W	Index of wages of non-physician personnel[5]	3.88	3.88
		(0.39)	(0.38)
CAGE	Percent of physicians 60 years and older[5]	29.5	29.5
		(14.5)	(14.4)
CFMG	Percent foreign medical school graduates[5,6]	9.3	9.5
		(6.8)	(6.5)
SPEC	Physician is specialist (self-designated)[7]	0.64	0.64
		(0.48)	(0.48)

(continued)

TABLE I (Continued)

Variable	Definition	Sample Means and Standard Deviations: National-Regional Sample	National Sample
BCERT	Physician is board-certified[7]	0.43	0.44
		(0.50)	(0.50)
FAC	Physician has faculty appointment[7]	0.10	0.08
		(0.30)	(0.28)
AGE	Physician is 60 years or older[7]	0.30	0.30
		(0.46)	(0.46)
FMG	Physician graduate of foreign medical school[6,7]	0.10	0.10
		(0.30)	(0.30)
CH	No. of children of female physicians[7]	—	0.03
		(—)	(0.28)
MAR	Physician is married[7]	—	0.91
		(—)	(0.28)
PY	Physician has $10K + in nonemployment income[7]	—	0.17
		(—)	(0.38)
HL	Physician has health problem[7]	—	0.16
		(—)	(0.36)

[1]Deflated
[2]Defined for physician's Blue Shield plan area.
[3]Defined for physician's county.
[4]Defined for physician's state.
[5]Defined for physician's PSU.
[6]Concise definition may be misleading. See text.
[7]Defined for the individual physician.
[8]The Blue Shield payment means and associated standard deviations correspond to the payment regressions in Table 2. The means and standard deviations for UN and AGR are from the hospital and office visit regressions, respectively. Otherwise, the means and standard deviations are from the samples used to estimate the probit regressions presented in Table 3.

TABLE 2

Blue Shield Payment Regressions

Reg. No.	Dependent Variable	Explanatory Variables: BD49	BD51	BDSP	COM	MSOC	Y	UN	AGR	W	CAGE	CFMG	SPEC	BCERT	AGE	FMG	Constant	
1.	Followup	1.30[1]	1.65[1]	0.045	-0.29	0.74[3]	0.0013[1]	0.018	--	0.76[3]	-0.018	-0.034	1.05[1]	0.64[2]	-0.27	-0.58	-0.31	R^2=0.15
	hospital	(0.44)	(0.46)	(0.57)	(0.33)	(0.56)	(0.0003)	(0.018)	(--)	(0.40)	(0.012)	(0.024)	(0.33)	(0.32)	(0.30)	(0.43)	(--)	F(14,861)
	visit	[0.12]	[0.15]	[0.00]	[-0.03]	[0.07]	[0.57]	[0.04]	[--]	[0.28]	[-0.05]	[-0.03]	[0.10]	[0.06]	[-0 .03]	[0.05]	[--]	-10.9
2.	Followup	1.05[3]	2.40[1]	1.29[3]	2.57[1]	0.50	0.00093[1]	--	-0.028	1.44[1]	0.033[2]	-0.17[1]	1.34[1]	0.53	0.50	-0.34	-6.17	R^2=0.31
	office	(0.63)	(0.56)	(0.69)	(0.38)	(0.71)	(0.00032)	(--)	(0.037)	(0.41)	(0.014)	(0.03)	(0.36)	(0.36)	(0 .32)	(0.54)	(--)	F(14.518)
	visit	[0.12]	[0.28]	[0.15]	[0.31]	[0.06]	[0.51]	[--]	[0.01]	[0.66]	[0.11]	[0.16]	[0.16]	[0.05]	[0.06]	[-0.04]	[--]	-16.5
3.	Inguinal &	4.89	11.52	-40.45[2]	26.67[1]	14.41	0.033[1]	--	4.82[1]	17.75	0.42	-1.58	21.06[3]	20.90[2]	-13.26	6.75	-30.09	R^2=0.26
	hernia	(14.27)	(12.99)	(17.77)	(10.14)	(17.21)	(0.009)	(--)	(1.39)	(16.44)	(0.47)	(0.84)	(12.64)	(10.69)	(9.64)	(14.07)	(--)	F(14,220)
	repair	[0.02]	[0.04]	[0.16]	[0.10]	[0.06]	[0.62]	[--]	[0.05]	[0.27]	[0.04]	[-0.06]	[0.08]	[0.08]	[-0.05]	[0.03]	[--]	-5.5
4.	Diagnostic	12.17[3]	10.29	-8.07	10.55[2]	-9.19	0.012[1]	0.21	--	30.79[1]	-0.033	-0.66[1]	18.84[1]	3.02	-0.64	-8.70	-77.01	R^2=0.30
	D and C	(6.26)	(6.69)	(8.83)	(4.79)	(8.49)	(0.004)	(0.26)	(--)	(5.86)	(0.19)	(0.37)	(5.86)	(5.10)	(4.43)	(6.84)	(- -)	F(14,320)
		[0.10]	[0.09]	[-0.07]	[0.09]	[-0.08]	[0.48]	[0.04]	[--]	[0.92]	[-0.01]	[-0.05]	[0.16]	[0.03]	[-0.01]	[-0.0 8]	[--]	-9.6
5.	Complete	0.24	1.12[2]	1.66[1]	0.25	-0.62	0.00041	-0.040[3]	--	-0.54	-0.0033	-0.095[1]	0.21	-0.32	-0.33	-0.44	9.69	R^2=0.19
	blood	(0.49)	(0.56)	(0.77)	(0.42)	(0.84)	(0.00032)	(0.021)	(--)	(0.40)	(0.0039)	(0.030)	(0.40)	(0.39)	(0.39)	(0.60)	(--)	F(14,323)
	count	[0.04]	[0.17]	[0.25]	[0.04]	[-0.09]	[0.30]	[-0.13]	[--]	[-0.33]	[-0.01]	[-0.12]	[0.03]	[-0.05]	[- 0.05]	[0.07]	[--]	5.4
6.	Electro-	-0.24	2.30[1]	-1.59	0.19	2.82[1]	0.00086[2]	--	0.064	-1.46[1]	-0.0064	-0.015	1.76[1]	0.56	-1.01[2]	-1.77[1]	15.03	R^2=0.27
	cardiogram	(0.68)	(0.66)	(1.07)	(0.48)	(1.00)	(0.00043)	(--)	(0.065)	(0.66)	(0.021)	(0.039)	(0.50)	(0.50)	(0.50)	(0.68)	(--)	F(14,435)
		[-0.01]	[0.13]	[-0.09]	[0.01]	[0.16]	[0.24]	[--]	[-0.01]	[-0.34]	[-0.01]	[-0.01]	[0.10]	[0.03]	[-0.06]	[-0.01]	[--]	-11.5

[1]Statistically significant at the 1 percent level
[2]Statistically significant at the 5 percent level
[3]Statistically significant at the 10 percent level

A self-perpetuating board may or may not be subject to medical society influence. "Self-perpetuating" amounts to "more of the same." The signs on BDSP vary; it is best to conclude that on average, payments are about the same as for the reference group, holding all the other factors in the regression constant. As seen in Table 1, only 9 percent of the physicians in the national-regional sample fall into the BDSP category, far fewer than those in BD51 (54 percent). Hence, any public policy specifically addressed to the BDSP plans would have a smaller potential effect in any event.

With one exception, control of all committees (COM) has a positive impact in five of the six regressions; the coefficient is statistically significant in three out of six regressions. In one instance, followup office visits, the estimated effect on payments is substantial, 31 percent. It is noteworthy that COM represents a rather independent dimension of physician control; simple correlations with BD49 and BD51 tend to be quite small.

As noted earlier, the vast majority of Blue Shield plans have formal medical society approval. Simple correlations indicate that MSOC is positively related to BD51 and negatively related to BD49. In general, the MSOC coefficients imply that payment levels are higher in plans with medical society approval, but there are two exceptions (diagnostic D and C and complete blood count).

The payment regressions include three variables representing exogenous influences on the demand for complete insurance coverage: *per capita* income and measures of importance of unionization and agricultural employment. As mentioned earlier, several other demand variables were included in preliminary regressions, but none of these had a statistically significant impact on payment levels. Of the three present in the regressions in Table 2, only *per capita* income (Y) demonstrates a consistently meaningful impact on Blue Shield payments. Not only is the Y parameter estimate statistically significant in five out of six regressions, but the associated elasticities, ranging from 0.24 to 0.57, are substantial. Results on the unionization and agricultural percentages are disappointing, especially in view of past research on demand for insurance.

Three variables in addition to Y represent exogenous factors accounting for shifts in the physician supply curve. In four of the six regressions, the wage variable (W) has a positive impact on payment levels, and the W coefficient is statistically significant in three of the four. In all three instances, associated W elasticities are substantial, ranging from 0.28 for hospital visit to 0.92 for diagnostic D and C reimbursements. The high W elasticities for the followup office visit and diagnostic D and C are understandable since these procedures are aide-intensive. But the complete blood count also relies extensively on aides, and the -0.33 estimated elasticity for this procedure is surprising. Parameter estimates on CFMG are uniformly negative and often statistically significant. Although generally negative, the CAGE coefficients are positive in two cases.

Finally, the positive signs on SPEC imply that Blue Shield plans generally recognize specialty for reimbursement purposes. In preliminary regressions, a variable representing the percentage of specialists in the physician's PSU showed insignificant impacts on reimbursements, probably because of its correlation with CAGE. With one exception, board-certified physicians are paid more. In a descriptive analysis of Medicare payment levels, Muller and Otelsberg (1979) found the same anomalous result, that is, general practitioners receive higher payments for a complete blood count. I dropped a variable identifying physicians with clinical medical school appointments from the payment regressions after it showed no impact on Blue Shield payment levels. As expected, older and foreign-trained physicians are paid less, holding other factors constant.

Participation Regressions

Table 3 presents reduced form participation regressions. Since the dependent variable is binary (equals I for participating physicians), probit is an appropriate estimator. The first regression uses the entire national-regional sample. The second, which includes four physician characteristics variables unavailable from the regional survey, is based on the national survey. With probit, even a linear functional form generates non-linear first derivatives. For this reason, approximate marginal effects, evaluated at the observational means, are presented in Table 3 for the binary explanatory variables. Associated elasticities are shown for their continuous counterparts.

As above, primary interst centers on the Blue Shield plan variables. Given a positively-sloped supply curve, if physician control results in higher Blue Shield payments, physicians should be more willing to accept Blue Shield payment as payment-in-full. As seen in Table 3, physicians practicing in areas where medical societies make appointments to Blue Shield boards are more likely to participate. The positive and statistically significant coefficients on BD49 and BD51 are consistent with the results on Blue Shield payments. However, the fact that the estimated marginal impacts for BD49 are higher is somewhat surprising, since the BD51 variable tends to have a stronger effect on payments levels. In the national-regional regression, for example, the probability that a doctor in a BD49 plan area participates is 0.20 higher than if there is no apparent role for the medical society in Blue Shield board apointments. The difference between BD51 and "none apparent" is only 0.14. I am not able to explain this pattern. It is noteworthy that this result is insensitive to alternative specifications and estimators (OLS, not shown, versus probit). Although this pattern is unexpected, conflicting relative impacts do not detract from the overall conclusion that both payment levels and participation are higher when physicians' organizations have some control over board appointments.

TABLE 3

Participation Regressions						
Explanatory Variables	Regressions		Estimated Impacts			
	(1) National-Regional Sample	(2) National Sample	Marginal Effect from Regression 1	Elasticity	Marginal Effect from Regression 2	Elasticity
BD49	0.83[1]	0.89[1]	0.20	–	0.14	–
	(0.14)	(0.20)				
BD51	0.53[1]	0.38[2]	0.14	–	0.08	–
	(0.13)	(0.18)				
BDSP	1.36[1]	1.62[1]	0.31	–	0.16	–
	(0.25)	(0.39)				
COM	-0.48[1]	-0.49[1]	-0.08	–	-0.06	–
	(0.10)	(0.14)				
MSOC	0.087[1]	0.070[3]	0.02	–	0.01	–
	(0.027)	(0.039)				
Y	-0.00030[1]	-0.00047[1]	–	-0.27	–	-0.30
	(0.00009)	(0.00012)				
W	0.27[3]	-0.41[2]	–	-0.22	–	-0.19
	(0.14)	(0.20)				
CAGE	0.018[1]	0.014[2]	–	0.10	–	0.08
	(0.004)	(0.006)				
CFMG	-0.018[2]	-0.024[2]	–	0.04	–	0.03
	(0.009)	(0.012)				
SPEC	0.054	0.12	0.01	–	0.02	–
	(0.113)	(0.15)				
BCERT	-0.099	-0.12	-0.02	–	-0.02	–
	(0.11)	(0.14)				
FAC	-0.33[2]	-0.51[1]	-0.07	–	-0.10	–
	(0.14)	(0.20)				
AGE	0.15	0.39[1]	0.03	–	0.05	–
	(0.11)	(0.15)				
FMG	0.16	0.41[3]	0.03	–	0.05	–
	(0.16)	(0.21)				
CH	–	0.18	–	–	0.02	–
	(–)	(0.19)				
MAR	–	0.006	–	–	–	0.00
	(–)	(0.21)				
PY	–	-0.25	–	–	-0.04	–
	(–)	(0.16)				
HL	–	-0.021	–	–	0.00	–
	(--)	(0.17)				
Constant	2.60[1]	4.27[1]	–	–	–	–
	(0.76)	(1.15)				
Observations	1199	718				

[1]Statistically significant at the 1 percent level
[2]Statistically significant at the 5 percent level
[3]Statistically significant at the 10 percent level

The participation results on BDSP and COM, however, seem to involve more important contradictions *vis-a-vis* those on payments. Physicians located in plan areas where the board is self-perpetuating are more likely to participate than physicians in areas in which medical societies appoint the boards. Yet in the previous table, half of the BDSP coefficients were negative. Some of the variability in the BDSP payment coefficients may be due to inadequate sample size. For example, the largest positive and negative BDSP estimated effects in Table 2, for complete blood count and hernia repairs, respectively, are based on samples of 28 and 34 observations. The hospital and office visit estimates in Table 2 and the national-regional BDSP parameter estimates in Table 3 are all based on samples of BDSP physicians over three times as large. It is best to await larger samples before making much of results on self-perpetuating boards. Although self-perpetuating Blue Shield plans are now comparatively rare, if many change to self-perpetuating from medical society-appointed boards as a result of antitrust pressures, these arrangements would merit a closer look.

In Table 2, the COM coefficients were positive with one important exception (hospital visits), although the estimated impacts tended to be lower than for BD51. The negative sign on the COM coefficients in Table 3 and the implied small, negative marginal effects suggest either that (1) physician control of Blue Shield committees is not an adequate measure of overall physician control, (2) the relevant influence is inadequately measured (for example, control of a few committees rather than of all five may be key), or (3) overall physician control does not affect payments and participation in a way predicted by the analytic framework. Given the results on other Blue Shield plan variables, the third explanation is by far the least likely one.

The MSOC coefficients imply that plans with formal medical society approval have 1 to 2 percent higher participation rates on average. This is consistent with estimated impacts of MSOC on payments.

As in past research on physician participation in Blue Shield and Medicaid plans, higher *per capita* income deters participation, and the associated elasticity is substantial (Sloan and Steinwald, 1978; Sloan, Cromwell, and Mitchell, 1978a, 1978b). The positive Y coefficients in Table 2 reflect both a higher demand for complete insurance coverage and an inward supply curve shift, because physicians can command higher fees from non-service benefit patients in high *per capita* income areas. The negative impacts of Y on participation in Table 3 suggest that the latter supply shift effect has a dominant influence on participation.

As seen in Table 2, higher wages of non-physician personnel are not always reflected in higher Blue Shield payments, and, even when W has a positive effect, the associated elasticity is far less than one. Thus, the negative implied effects of W on participation in Table 3 come as no surprise.

The remaining estimated marginal impacts and elasticities in Table 3 are quite small. The largest effect of these variables corresponds to physicians with faculty affiliations (FAC). The analysis of payment levels indicates that Blue Shield generally does not reward faculty affiliation, perhaps because it is costly for the plans to take more than a few "objective" characteristics into account for reimbursement purposes.

Further Discussion and Conclusions

As of the mid-1970s, most boards of Blue Shield plans were selected by medical societies. As a rule, medical society control over board appointments has led to the selection of physician-dominated boards. In fact, the relationship between the method of board selection and the proportion of physicians on boards proved to be so close that precise estimates could not be obtained when both selection method and occupational mix of board variables were included. For this reason, the physician proportion on Blue Shield boards was eliminated from the regressions.

With greater medical society involvement in board selection, Blue Shield payments for specific types of services tend to rise. Consistent with this finding, physician participation in Blue Shield service benefit programs rises when medical societies control board appointments.

From the vantage point of cost containment, physician control not only raises procedure-specific reimbursements but is likely both to increase physicians' fees overall and reduce physician willingness to accept Medicaid and Medicare payments as payment-in-full. Sloan, Cromwell, and Mitchell (1978a, 1978b), using the same data base as in this study, found that higher Blue Shield fee schedules discourage physician involvement with Medicaid. Associated elasticities in the -0.3 to -0.5 range indicate that this "discouragement effect" is far more than trivial.

More generous Blue Shield payments in effect bid physicians' services away from other groups. Thus, although a policy aimed at reducing physician control over Blue Shield plans would reduce the access of its enrollees to physicians, it would probably have the opposite impact on persons covered by other third party payment programs. The "trust-buster," therefore, is not necessarily faced with the typical trade-off between cost and patient access. Severing ties between organized medicine and Blue Shield plans may well result in improvement on both counts.

To date, no empirical study has established a link between Blue Shield reimbursement levels and physicians' fees. Using a standard model of firm behavior, the potential impact of reimbursement on fees is unambiguous. To the extent that the impact is shown to be important (and given Blue Shield's typical market share, this is likely), the implications of control are even more far-reaching.

Without denying the overall merit of severing ties between Blue Shield plans and organized medicine, the following points require consideration. First, though positive and consequential, the estimated impacts of control variables on Blue Shield payment levels are by no means huge. Eliminating physician control is not a panacea. Second, the single cross-section available for this study only permits us to assess payment levels. The data do not allow inferences about differential rates of change in payments.

Third, some anomalous findings reported above suggest that there is more to be learned about the rather intricate interrelationships between physicians and Blue Shield plans. It is clear that physicians must provide third-party payers with expertise, but as technical consultants rather than as decision-makers. Physician presence on various Blue Shield reimbursement committees should not be questioned. Considering all the evidence, one should conclude from this study that physician control of committees (as contrasted with control of boards) does not generally lead to higher Blue Shield payments and higher rates of physician participation (although in general, Blue Shield payments are higher when committees are controlled). There is more to be learned about how these committees function, and under what circumstances, if any, physician domination of committees yields undersirable outcomes.

Fourth, this analysis has only investigated one aspect, albeit an important one, of physician control. Other potential consequences of control, such as the effect on reimbursement of non-physician practitioners, should be assessed.

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Large Medicaid Practices: Are They Medicaid Mills?

by Janet B. Mitchell, Ph.D. and Jerry Cromwell, Ph.D.

Descriptive studies have suggested that large Medicaid practices are run by poorly trained but wealthy physicians who spend inadequate time with patients and overprescribe tests and procedures. This study focuses on whether such behavior is limited to only a few true "Medicaid mills" or is characteristic of all large Medicaid practices.

The analysis was based on a theoretical model of large Medicaid practices versus small Medicaid practices. The model considered the differences in quality of care, variations in physicians' credentials, and physicians' wages. The findings of the report indicate that large Medicaid practices are not the Medicaid mills they are often accused of being. A comparison of quality of care, as measured by length of visit and number of ancillary services rendered, shows little difference between large Medicaid practices and small ones, with the exception of the large Medicaid practices ordering more injections. However, there was a difference found between the credentials of those physicians in large Medicaid practices and those in small ones, with the large practices having more foreign medical graduates and fewer board-certified physicians. Lastly, the authors found that large Medicaid practice physicians' hourly earnings were lower than those in small Medicaid practices.

If you are a Medicaid patient, you can expect to be treated in a clinic located in a dilapidated part of the city.

The outside of these clinics, or Medicaid mills, are (sic) garish . . . They may be brightly painted, with awnings, banners, and pennants . . . The front window lists an impressive array of services—everything from a psychiatrist to a podiatrist.

Inside, the mill will be cramped and sparsely furnished. It will be dirty. Cleanliness is not prized in Medicaid mills; it costs too much money. The floors look like they haven't been swept in a month and the rest rooms are abominable.

As you enter a mill you will be greeted by a receptionist or someone who looks like a nurse . . . You may be asked whom you want to see or what is your medical problem. Or you may not.

Now you wait for an hour, sometimes two . . .

When you do get to see a practitioner, your visit will be brief—usually from three to five minutes . . .

You will be given a general examination no matter how specific your complaint. If blood pressure is taken or a stethoscope is used, the odds are it will be done through your clothing . . . Medicaid doctors do not like touching their patients.

At some point, the doctor will take blood (which) confirms that treatment has been rendered . . . But, perhaps just as important, samples presented to clinical laboratories will generate a return of $15 each from the laboratory.

In addition, you are going to be asked for a urine sample; you will be given a number of x-rays and perhaps a shot or two . . .

If you are not sick, you won't be told you're not sick. If you are sick, the odds are you won't be helped.

Senator Frank Moss (1979)

Senator Moss' vivid description of the notorious "Medicaid mill" arouses both anger and disappointment. We are angry that government and State medical societies allow such abuses to occur, disappointed that the Medicaid poor have not been integrated into mainstream American medicine. How does this happen? What can be done about it? Before attempting an answer, we might ask how big a problem do we have? A few extraordinary incidents would suggest a very direct approach: identify individual abuses through various

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means (for example, random sampling of claims, unannounced visits to garish store-front practices) and then prosecute the offenders. If, however, the problem is more widespread, a less direct approach may be required, one which reduces the motives or opportunity for wrongdoing.

The few studies conducted to date yield only suggestive evidence of inadequate care in large Medicaid practices. Perhaps the best known and most original of these studies is that conducted by Senator Frank Moss in his role as chairman of the Senate Subcommittee on Long Term Care (U.S. Senate Special Committee on Aging, 1976). Senator Moss and his staff employed two innovative techniques to identify practices in Chicago and New York City. First, staff posed as physicians and opened a store-front practice in Chicago. Immediately, they were beseiged by representatives from different clinical laboratories who offered large kickbacks in return for all laboratory business. Using Medicaid claims data, staff members identified physicians who used these particular laboratories and interviewed 50 of them. Many of these physicians were foreign medical graduates who confirmed that they received kickbacks from the laboratories in question, as well as from other providers. Second, Senator Moss and his staff paid incognito visits to suspect health facilities in Chicago and New York City ghetto neighborhoods, where they posed as Medicaid patients with fictitious complaints. Based at least on their reported experiences (and summarized in the quote above), these facilities qualify as Medicaid mills.

The Moss committee report provides a colorful, distressing portrait of Medicaid mills. While fraudulent behaviour and low quality care certainly were characteristic of these facilities, findings are limited to the handful of practices actually visited. In particular, we have no way of determining whether such behaviour is characteristic of large Medicaid practices (LMPs) generally. A high percent distribution of Medicaid patients cannot be considered *prima facie* evidence of a mill, a point we return to in detail later in this paper.

Poor quality of care in LMPs is alleged to be a function of a lack of physician credentials, a high caseload, and excessive use of ancillary services, such as laboratory services and X-rays. The Moss report and a 1970 Senate Finance Committee report provide some evidence of ancillary overprescription (U.S. Senate Committee on Finance, 1970). LMP physicians are generally believed to have less specialized training or less adequate training than other physicians. In particular, they have been described as disproportionately older (Kavler, 1969), general practitioners (Sloan, Cromwell, and Mitchell, 1978; Jones and Hamburger, 1976), foreign medical graduates (Studnicki *et al*, 1976; Sloan, Cromwell, and Mitchell, 1978), and lacking hospital affiliations (Kavler, 1969; Bloom *et al*, 1968). Finally, LMP physician caseloads have been described as exceedingly high, seriously limiting the amount of time the physician spends with any one patient (Bloom *et al*, 1968).

These descriptive studies suggest that large Medicaid practices are run by poorly trained but wealthy physicians who spend inadequate time with patients and overprescribe tests and procedures. Based on these studies, we cannot determine whether such behavior is characteristic of all LMPs or whether it is limited to only a few true "Medicaid mills." Only one study used a national sample, but it did not examine the question of LMPs directly (Sloan, Cromwell, and Mitchell, 1978). The remaining studies were based on a few selected practices, usually in the same two cities (Chicago and New York). Perhaps most important, these studies generally had no other physician practices for comparison purposes. It is thus almost impossible to determine how many laboratory tests and injections are too many, whether office visits are too short, or whether practice loads are excessively high. The survey data presented in this paper enable us to compare the behavior in LMPs with that of other physician practices on a national basis for the first time.

Data Sources

The primary data base for this analysis is the 1976 Physicians' Practice Cost Survey. Using these data, the size distribution of Medicaid practices was calculated from the individual physician's response to the following question: "About what percentage of your patients have Medicaid?"

Measurement error may be present if physicians refused to participate in the survey or if they reported inaccurate or incomplete information during the interview. Given the negative publicity surrounding LMPs, physicians with such practices might be more reluctant participants. It is unlikely, however, that any significant non-response bias has been introduced, for several reasons.

First, the explicit objective of the survey was not to investigate such practices, and in fact it included only a single question on the extent of Medicaid participation. Second, analysis of the 1975 Physicians Practice Costs Survey from the preceding year had found that non-respondent physicians did not differ from cooperating physicians along characteristics believed to be associated with LMPs, such as specialty, board-certification, and foreign medical graduate (FMG) status (Sloan, Cromwell, and Mitchell, 1978). Finally, statistical weights associated with the 1976 sample include adjustments for non-response.

Another source of potential error is the extent of under- or over-reporting by physicians who did take part in the survey. Two areas of particular concern are physician net incomes and work effort. AMA questionnaire data on physician incomes and hours of work were used to assess the accuracy of survey responses (AMA, 1979). Specialty-specific means from the two sources were quite comparable. Non-participation and non-response among physicians operating true Medicaid mills are still likely, even given the validation procedures. We do not know how serious a bias this creates.

[1]Data collection actually took place in 1977; cost and income data refer to the previous calendar year, hence its designation as a 1976 survey. All other data, such as fees and visits, refer to the actual year in which they were obtained (1977).

Three additional data sources were merged with the 1976 survey for this analysis. We obtained biographic information on individual survey physicians from the *AMA Masterfile*, including such data as physician age, board-certification, and medical school. Variables describing the physician's county, such as demographic characteristics, were drawn from the Area Resource File. Two community variables, *per capita* income and physician-population ratios, were obtained from a more up-to-date source: the AMA's *Physician Distribution and Medical Licensure in the U.S., 1976*.

Analysis of Large Medicaid Practices

The distribution of Medicaid participation rates is shown in Figure 1. The numbers at the top of each bar represent the percent of total physicians in the Medicaid practice size class. The deciles along the abcissa represent the percent of practice patients who receive Medicaid. The histogram displays a marked right skew; almost one-fourth of the sample (23%) report that they do not treat Medicaid patients. Most participating physicians have fairly small Medicaid practices. For purposes of this analysis, LMPs will be defined as practices in which 30 percent or more of the physicians' patients receive Medicaid. Thirty percent is a full standard deviation above the mean average of Medicaid patients in a practice (12.7%). Approximately 14 percent of sample physicians fall into this "outlier" category. It is plausible, however, that practices with an even higher concentration of Medicaid patients may share more of the characteristics associated with a mill. In order to test this, physicians with "extra-large" Medicaid practices (ELMPs) those with at least one-half of their practice devoted to Medicaid patients, are also compared.

Medicaid participation clearly differs across practices, but it is possible that large Medicaid practices treat only a relatively small proportion of total Medicaid patients. If so, policymakers might be less concerned about the possibility that these large Medicaid practices are mills. Using Medicaid mix and caseload data, we derived the size distribution of Medicaid patients, measuring inequalities in the distribution of Medicaid patients across physicians. The observed distribution indicated considerable unevenness (Mitchell and Cromwell, 1979); three-quarters of sample physicians care for only 26 percent of the total Medicaid population. Almost one-third (31.8%) of all Medicaid patients, on the other hand, are treated by 5.5 percent of the physicians. A small number of physicians have assumed responsibility, whether through accident, altruism, or avarice, for a large proportion of the nation's poor.

Before analyzing the large Medicaid practices in detail, we will briefly compare the size distribution of Medicaid practices across the specialty groups. Medicaid participation rates for primary care physicians were previously reported by Sloan, Cromwell and Mitchell (1979). This is the first time, however, that national estimates have been available for the other specialties as well. As seen in Table 1, participation levels vary considerably by specialty, ranging from 6.1 percent for allergists to 16.2 percent for otolaryngologists, an average of approximately 12.7 percent.

With the notable exception of obstetrician-gynecologists (OB-GYNs), primary care practitioners are more likely to have LMPs than are the subspecialists. In part, this may reflect the role of primary care physicians as gatekeepers to the rest of the health care system. In addition, usual fees for primary care practitioners may be closer to the Medicaid allowed fee than those of subspecialists, thus encouraging them to see a larger number of Medicaid patients. At the other extreme, psychiatrists have one of the lowest participation rates of all specialists and are among the least likely to run large Medicaid practices. This is almost certainly a direct result of State progam limitations on benefit levels and eligibility criteria. Federal regulations mandate only limited coverage of mental health services, and benefits are biased toward institutional services (Medicaid/Medicare Management Institute, 1979).

The descriptive and multivariate analyses of LMPs that follow are limited to the five major specialties: general/family practice, general surgery, internal medicine, OB-GYN, and pediatrics (with an unweighted sample size of 1,796). These specialties constitute over one-half of office-based, patient care physicians nationwide. Primary care physicians also provide access to ambulatory medical care, the area of greatest concern to Federal policymakers. Finally, it is these physicians who have been most frequently identified as running "Medicaid mills."

Comparisons and statistical tests of LMPs may vary as a function of the physician group used as a reference point. By the very fact of their non-participation, physicians with no Medicaid patients are unique; they constitute a small group relative to physicians with small Medicaid practices (SMPs) and they tend to be older and politically more conservative (Sloan, Cromwell, and Mitchell, 1978). Physicians with SMPs, on the other hand, can be considered a modal form of medical practice and one that policymakers want to encourage. In both descriptive and multivariate analyses, LMP physicians (and those with ELMPs) will be contrasted with SMP physicians.

Practice Location

LMPs are often considered an urban phenomenon, located primarily in the ghettos of our largest cities. This image, however, does not square with the facts. Both SMPs and LMPs exhibit the *same* distribution across large (greater than 1.4 million people) and small metropolitan areas, while ELMPs are actually more prevalent in small metropolitan areas. ELMPs, therefore, are more likely than SMPs to be in small cities, which is certainly unexpected. Nearly one out of every five LMPs and ELMPs, furthermore, is located in nonmetropolitan or rural areas. Much of the rural population is very poor, a fact often overlooked because of the greater visibility of the urban poor. Most LMPs are not located in the large industrial cities of the North, but rather in the South and West. The ELMPs, however, are located primarily in the Northeast, as expected.

FIGURE 1
Medicaid Participation Rate for All Physicians

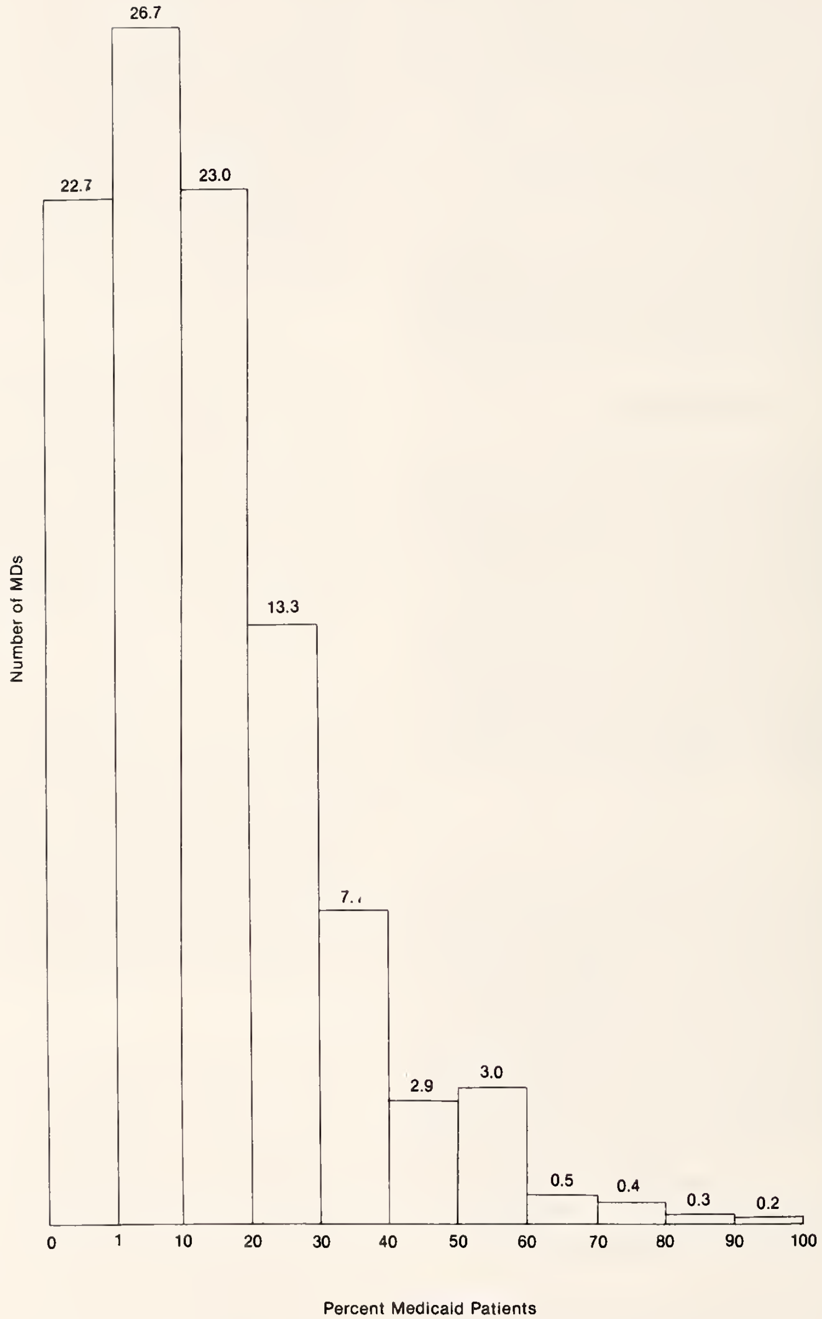


TABLE 1

Size Distribution of Medicaid Practices by Specialty

Specialty	Medicaid Practice Size: None	Small	Large	Average Participation Rate
Primary Care	21.6%	62.6%	15.8%	13.3%
General Practice	24.3	60.8	14.9	13.5
General Surgery	8.4	75.1	16.5	14.3
Internal Medicine	18.1	62.5	19.4	14.5
Obstetrics/ Gynecology	36.8	53.3	9.9	8.3
Pediatrics	24.1	58.5	17.4	14.3
Medical Specialties	32.2	58.8	9.1	9.0
Allergy	40.0	55.3	4.7	6.1
Cardiology	39.2	55.7	5.1	6.7
Dermatology	26.1	56.5	17.4	13.1
Gastroenterology	15.2	77.9	6.9	10.0
Surgical Specialties	15.3	71.7	13.6	13.3
Neurosurgery	18.3	71.6	10.1	10.9
Ophthalmology	12.4	72.7	14.9	14.4
Orthopedic Surgery	19.8	71.2	9.0	10.7
Otolaryngology	13.2	66.5	20.3	16.2
Urology	14.1	69.2	16.6	14.3
Psychiatry	39.9	51.7	8.4	8.0
All	22.6	62.9	14.5	12.7

Physician Incomes

One of the biggest concerns of policymakers is the income enjoyed by physicians in LMPs. The presumption is that many are making extraordinary incomes, feeding off the public largesse. After adjusting for specialty and geographic cost-of-living differences, however, there is little evidence to support this claim; no salient pattern exists as Medicaid participation increases. There are no significant differences in mean net incomes between SMP and LMP physicians. General practitioners, general surgeons, and internists with ELMPs actually earn significantly less; the average ELMP general practitioner earns $44,447 compared with $56,841 for the SMP colleague. OB-GYNs and pediatricians have net incomes comparable with their SMP peers.

Yes, but what about the outliers? How many LMPs and ELMPs enjoy extraordinary incomes? Table 2 presents income size distributions, by specialty, for SMPs and LMPs. (ELMPs have been merged with LMPs because of small sample sizes.) Except for internists, 20 percent of whom in LMPs enjoy incomes in excess of $80,000 vs. only 10 percent in SMPs, the size distributions show no unexpectedly large number of high income LMPs. Still, the fact that 36 percent of surgeons, 20 percent of internists, and 20 percent of OB-GYNs earn over $80,000 in practices serving large numbers of low-paying Medicaid patients is interesting. Are these the Medicaid mills Senator Moss has investigated? We return to this provocative question in a later section.

Adjusting income for work effort does not alter the overall conclusion that LMP and ELMP physicians, as a whole, are not enjoying extraordinary returns. If anything, hourly earnings are *lower* in practices serving large numbers of Medicaid patients. This is particularly true of general practitioners in LMPs and ELMPs whose earnings per hour are (respectively) four to seven dollars less than those in SMPs. Even though LMP and ELMP physicians report incomes and earnings per hour no greater than in other practices (and often lower), one could still argue that these hourly earnings are unjustified given their background and training. This argument is taken up in the following section on physician credentials.

Physician Credentials

Physicians with LMPs have been characterized as having fewer credentials on average than other physicians. In particular, LMPs are thought to be disproportionately operated by older physicians, non-specialists, foreign medical graduates (FMGs), non-board-certified practitioners, and by physicians lacking hospital affiliations. To the extent that these physicians have less or inadequate training, Medicaid recipients in their practices may be receiving lower quality care. Lack of specialty training or board-certification does not

TABLE 2

Size Distribution of Physician Incomes, Small and Large Medicaid Practices

Income Category	General Practitioners		General Surgeons		Internists		OB-GYNs		Pediatricians	
	LMP	SMP	LMP	SMP	LMP	SMP	LMP	SMP	LMP	SMP
$20,000 or less	3%	6%	7%	1%	4%	1%	3%	3%	3%	6%
$20,000-40,000	17	15	12	10	14	9	7	12	23	20
$40,000-60,000	66	43	17	21	29	39	11	23	61	47
$60,000-80,000	8	20	28	40	33	41	59	38	4	6
$80,000-100,000	3	13	28	17	8	8	17	13	9	9
$100,000-+	3	3	8	11	12	2	3	11	0	2
Mean[1]	$53,111	$56,841	$72,209	$68,793	$62,740	$60,285	$71,784	$66,699	$47,213	$50,825

[1]Adjusted for cost of living

necessarily imply poor care; there are general practitioners and non-certified specialists who are excellent primary care physicians. If LMPs were to be dominated by such physicians, however, policymakers would be concerned over a possible lack of access by the poor to more specialized services.

LMP and ELMP physicians do have fewer credentials on average than do SMP physicians, but these differences are not linear with respect to size of Medicaid practice. General practitioners dominate the ELMPs; almost three-fifths of physicians in these practices (59.2%) are general practitioners, as compared with only 39.9 percent of the SMPs. By contrast, the LMPs include a significantly lower proportion of general practitioners (29.5%) and a significantly higher proportion of internists (30.5%) than do SMPs (39.9% and 20.9%, respectively). Both LMP and ELMP physicians are significantly less likely to be board-certified (32.1% and 15.9%), compared with 42.8 percent for SMPs.

Twice as many FMGs are found in LMPs than in SMPs; one out of every five physicians with a large Medicaid practice was trained outside the U.S. Using a more restrictive definition of Third World FMGs[2], LMPs include three times as many FMGs, 14.5 percent versus 4.8 percent. Surprisingly, the ELMPs do not include any more FMGs, however defined, than do the SMPs.

Some policymakers have expressed concern that LMP physicians are older and that this may detract from the quality of care, not because these physicians are incompetent, but simply because they have not been trained in the newer medical technology. Similarly, physicians without hospital affiliations may provide less up-to-date care if they are unable to admit their own patients to the hospital for care. Only ELMP physicians appear to fit this characterization; they are significantly more likely to be 60 years of age or older and less likely to be affiliated with a hospital.

Earlier we introduced the possibility that LMP physicians may be enjoying incomes that, if not excessive compared to other physicians, were relatively high given their background and training. To test this hypothesis, we regressed adjusted hourly earnings of all primary care physicians on the list of physician credentials (including age) and other exogenous variables that might affect returns to labor. Residuals from this regression should reflect returns over-and-above those attributable either to the background and training of the physician or to location choice. Holding both credentials and economic factors constant, there is no evidence that LMP and ELMP physicians as a *group* earn extraordinary earnings. In fact, just the opposite is the case: physicians with Medicaid-dominated practices earn significantly *less* per hour worked than their peers who see a smaller number of Medicaid patients, all else being equal.

Caseload and Work Effort

Physician caseloads have been a major concern in large Medicaid practices for two reasons. *First,* relatively high volume in these practices suggests that many Medicaid visits may be of marginal benefit or even unnecessary. Physicians who encourage unnecessary visits will clearly drive up Medicaid expenditures. *Second,* high LMP volume may be achieved through shorter physician contacts, thus lowering quality of care for Medicaid recipients.

[2]As some foreign medical schools are generally believed to have better curricula than others, we distinguish Third World FMGs from other FMGs. The Third World FMG is defined here as a graduate from a non-Western European, non-English speaking country. Graduates from Mexican schools are excluded, since many are American citizens.

Physicians in both LMPs and ELMPs have significantly more patient contacts *in toto* than do those in SMPs, approximately 10 percent more on average (Table 3). Allocation of total visits also varies across visit categories. ELMP physicians are less hospital based than those in SMPs, providing significantly fewer visits in inpatient settings and more in their offices. Both LMP and ELMP physicians, however, allocate a significantly higher proportion of their caseloads to emergency room and clinic visits. Absolute ER/clinic visits are also significantly higher in LMPs and ELMPs, 14.4 and 14.5 visits per week, compared with 9.3 in SMPs. This is somewhat disturbing, as a major Medicaid policy objective is to discourage the use of institutional sources of ambulatory care.

LMP and ELMP physicians clearly have higher caseloads; for policy purposes, however, this might not matter if they worked longer hours. In fact, as seen in Table 3, there are no differences in total hours by size of Medicaid practice. This finding raises concern about the pace of office visits in LMPs. Are patients hurried through the physician's office on an assembly line basis? Table 3 suggests they are not. Physicians in large Medicaid practices do spend less time with office patients, but the differences are trivial; office visits are only two minutes shorter on average. Futhermore, the length of visit in ELMPs is no different than in SMPs.

Gross Revenues, Costs, and Markups

Besides the natural concern over the quality and continuity of care afforded Medicaid patients in LMPs, there is a general feeling, expressed in Congressional testimony and elsewhere, that significant numbers of LMP physicians are financially abusing the system. If this is the case, it is not reflected in physician net incomes, as we have already shown; high markups and gross billings, however, remain a concern.

Table 4 presents gross revenues, costs, and net revenues (or markups) per visit for the five primary care specialties by extent of Medicaid participation. Both gross revenues per visit and markups fall as extent of Medicaid participation increases. Excluding high income LMPs (HILMPs), LMP markups are only 82 percent of SMP markups ($9.12/$11.19); ELMP markups are only 58 percent as much ($6.51/$11.19). Including HILMPs, the average LMP/SMP markup ratio is 86 percent. LMP markups as a whole are lower primarily because of lower gross revenues per visit, not lower costs. Average costs per visit in LMPs are 96 percent of costs in SMPs, but gross revenues per visit are only 90 percent. ELMP gross revenues per visit are even lower (only 68 percent of SMPs). A breakdown by specialty shows essentially the same pattern of declining gross revenues and markups as Medicaid participation rises.

TABLE 3

Caseload, Visit Locus, and Work Effort by Size of Medicaid Practice

Effort Per Week	Medicaid Practice Size: None	Small	Large	Extra Large
Total Visits	157.1	169.3	188.1**	185.9**
Percentage[1]:				
Office	70.8%	61.6%	60.6%	69.3%***
Inpatient	21.8	28.6	25.5*	19.7***
Operations	1.8	2.2	2.7	1.0***
Emergency Room/Clinic	2.6	5.2	7.1**	7.7**
Nursing Home	1.4	1.6	3.0*	1.6
House Calls	1.6	0.7	0.5	0.7
Total Patient Care Hours	47.2	51.5	52.6	51.3
Length of Office Visit (minutes)	22.0	19.6	17.8**	19.7

[1]May not sum to 100%, due to rounding.
***Significant from SMP mean at 1% confidence level
**Significant from SMP mean at 5% confidence level
*Significant from SMP mean at 10% confidence level

TABLE 4

Gross Revenues, Costs, and Markups per Visit by Specialty by Size of Medicaid Practice

Specialty/Income or Cost Category	Medicaid Practice Size None	Small	Large[1]	Extra-Large[1]
General Practitioner				
GR/V	$16.22	$14.13	$11.28	$ 9.26
C/V	7.31	5.38	4.24	4.49
NET R/V	8.91	8.76	7.04	4.76
General Surgeon				
GR/V	25.93	20.96	22.46	14.29
C/V	7.89	6.22	8.90	6.44
NET R/V	18.04	14.74	13.56	7.85
Internist				
GR/V	18.76	18.41	13.24	20.40
C/V	6.37	6.40	5.80	7.58
NET R/V	12.39	12.01	7.44	12.82
OB-GYN				
GR/V	20.02	23.25	22.03	15.78
C/V	7.48	8.34	8.71	6.54
NET R/V	12.54	14.91	13.32	9.24
Pediatrician				
GR/V	15.87	11.79	12.00	9.08
C/V	5.28	4.50	4.87	4.39
NET R/V	10.59	7.29	7.13	4.69
Total				
GR/V	17.94	17.18	15.31	11.75
C/V	6.99	5.99	6.19	5.24
NET R/V	10.95	11.19	9.12	6.51

[1] Excludes high income Medicaid practices (over $80,000)

Key:
GR/V=gross revenues per visit
C/V=practice costs per visit
NET R/V=net revenues per visit (markups)

Ancillary Services

The excessive use of ancillary services is an identifying characteristic of Medicaid mills.

Although it is not possible to determine the medical necessity of the ancillaries LMPs provide, we can compare the frequency with which they are ordered to SMPs. The survey asked each physician to estimate the percent of office visits for which he or she ordered four types of services: laboratory tests, injections or immunizations, X-rays, and office surgery.

Evidence that large and extra-large Medicaid practices order excessive ancillaries is ambiguous at best. Higher utilization rates by one specialty are often offset by lower rates for another specialty. General surgeons and OB-GYNs with LMPs order significantly more tests, but internists, and pediatricians actually prescribe significantly fewer. ELMP physicians, futhermore, use laboratory services at the same rate as their colleagues in SMPs. Injections, however, are used at exceedingly high rates in both LMPs and ELMPs relative to SMPs. This prescribing behavior is shared by all specialty groups except pediatricians but is most pronounced among internists. ELMP internists order injections for almost one-half of all their office patients (45.2%), a rate almost three times that of SMP internists (16.2%).

There are no differences in X-ray use by size of Medicaid practice. Differences in office surgical rates are inconsistent, once broken down by specialty. General practitioners and internists in LMPs perform significantly more procedures, while surgeons and ELMP pediatricians perform fewer. The absolute levels of office surgery are generally low, however, in all groups.

Inputs

In addition to his or her own time, the primary inputs to the physician's practice are auxiliary staff, such as clerical and nursing personnel. Physicians vary considerably, however, in the number and type of such personnel and in the effectiveness with which they employ them. If physicians with LMPs are more efficient in their use of auxiliary staff, this may explain their higher practice volume. By delegating tasks to clerical and nursing staff, these physicians may increase their total productivity (visits per physician hour) and lower average costs per visit. Alternatively, LMP physicians may skimp on such inputs in order to lower practice costs and increase net revenues.

Table 5 presents the mean number of auxiliary staff per physician by size of Medicaid practice, both overall and disaggregated by type. LMPs employ significantly more nonphysician personnel, notably clerks, LPNs, and nurse practitioners. Their higher use of LPNs may partially explain why LMP physicians see more patients per hour, while more clerical personnel may be necessary to handle the added administrative work associated with Medicaid reimbursement. The ELMPs, however, do not employ significantly more clerks than SMPs, suggesting that they either find Medicaid administrative procedures less onerous to deal with or that they have become more proficient in obtaining payment. Although total staff-to-physician ratios are not higher in ELMPs, these practices do use significantly more nursing personnel, both RNs and LPNs. This suggests that ELMP physicians may engage in considerably more medical task delegation than other physicians.

Practice Size and Organization

Practice costs may be higher (or lower) in LMPs and ELMPs if their organizational form varies from that of other practices. Groups may achieve lower average visit costs than solo practices through economies of scale. Medicaid expenditures per patient may be higher, however, if excessive referrals are made to other physicians within the group (an alleged characteristic of Medicaid mills). Incorporation of a practice may have the dual effect of raising total practice costs and individual physician net (after tax) incomes.

Contrary to expectation, LMPs and ELMPs are significantly more likely to be solo, unincorporated practices. Sixty percent of SMPs are solo practices as compared with 75 percent of the LMPs and 89 percent of ELMPs. Only 3.3 percent of LMPs are groups of six to nine physicians, a slightly lower percentage than SMPs (3.8%). Also surprising is the fact that SMPs, rather than LMPs, are more likely to be incorporated.

Discriminant Analysis of Large Versus Small Medicaid Practices

Practices with a large proportion of Medicaid patients have been characterized as "mills," high volume, low quality operations run by highly paid physicians with few credentials. While results presented above corroborate some of these contentions, many of these characteristics are intercorrelated, and cross-tabular analysis does not adequately control for this. If LMPs are truly different from smaller Medicaid practices in ways that affect quality of care, we should be able to statistically distinguish between the two groups.

How might we identify Medicaid mills from large Medicaid practices generally? First, Medicaid mill physicians are expected to be earning higher incomes on average. Second, medical care will be significantly poorer in mills, as measured by shorter visit lengths, higher rates of ancillary use,

TABLE 5

Auxiliary Staff[1] by Size of Medicaid Practice (means)

	Medicaid Practice Size			
Type	None	Small	Large	Extra-Large
Total	1.57	2.10	2.58***	2.43
Clerks	0.87	1.22	1.60***	1.01
RNs	0.25	0.31	0.29	0.54***
LPNs	0.19	0.22	0.32**	0.58***
Technicians	0.24	0.29	0.35	0.21*
Nurse Practitioners	0.03	0.06	0.03**	0.09

[1]All staff are expressed as full-time equivalents per physician.

***Significant from SMP at 1% confidence level
**Significant from SMP at 5% confidence level
*Significant from SMP at 10% confidence level

and fewer inputs. While Medicaid mills will be run by less well trained physicians, this is not a necessary condition for a mill. Nevertheless, for policy purposes, we are concerned about a relative lack of training in LMPs, as this will restrict access by the poor to specialized services. If LMPs (and ELMPs) are a unique group, then a discriminant function with these variables (income, process measures of quality, and credentials) should distinguish them from other physician practices. Discriminant analysis is used to analyze two groups of practices: small and large Medicaid practices. (We omitted non-participants from this analysis.) Since practice characteristics are often different in LMPs and ELMPs, we will derive two discriminant functions: (1) where LMPs are defined as practices with 30 percent or more Medicaid patients (which we will call MILL1 for identification purposes) and (2) LMPs defined as at least 50 percent Medicaid patients versus all other Medicaid practices (MILL2).

Three sets of discriminating variables are included with each function: income, process measures of quality, and credentials. To adjust for differences in hours worked, we defined the income variable as the physician's imputed hourly wage (MDWAGE). We hypothesize that physicians in LMPs can be distinguished by their higher net earnings, all else being equal.

If LMPs tend to be mills, then they should be characterized by lower quality care on all dimensions. In particular, physicians in these practices should spend less time with patients, order more ancillary services, and employ fewer aides. The variable LOV, the length of time spent with each office patient, is measured in fractions of an hour. The variables TEST, SHOT, XRAY, and SURG are specified as the percent of office patients for whom the physician ordered laboratory tests, injections, X-rays, and office surgery, respectively. AIDE is the number of auxiliary staff employed in the practice and is expressed as full-time equivalents per physician.

Physician credentials include specialty, board-certification, FMG status, age, and hospital affiliations. These variables are included in part as adjustments for the process measures; variations in ancillary use between the two groups may reflect differences in specialty mix. Physician credentials are also of analytical interest in their own right. LMP physicians should be distinguishable from their colleagues as older, general practitioners and foreign medical graduates, without board certification or hospital affiliation. Specialty is specified as four dummy variables, GS, IM, OB and PED for general surgeons, internists, OB-GYNS, and pediatricians, respectively. General practitioners constitute the omitted category. BOARD and FMG both assume the value of one if the physician is board-certified, or if he or she is a Third World FMG. The variables MDAGE and HOSAFIL are set equal to one if the physician is 60 years or older or lacks hospital affiliations, respectively.

Empirical Findings

Table 6 presents the means of the discriminating variables and the results of the analysis. The statistically significant coefficients associated with many of the variables indicate that both functions do discriminate between the two groups. A negative sign indicates that LMPs share a particular characteristic, for example, have more FMGs, and that this characteristic distinguished them from smaller Medicaid practices.

MDWAGE, the physician's imputed net hourly wage, is a significant discriminatory variable in both functions. Regardless of how we define LMPs, physicians in these practices are distinguished from smaller Medicaid practices by their *lower* per hour earnings.

We included six process measures of quality in the analysis. If LMPs were mills providing poor quality care, then the four ancillary service variables (TEST, SHOT, XRAY, and SURG) should have significant negative coefficients, and the coefficients for the input variables (LOV and AIDE) should have significant positive signs. Based on prior expectations, LMPs have only a single mill-like characteristic: physicians in these practices do order significantly more injections. The relative magnitude of this variable nevertheless indicates that SHOT is a powerful discriminatory variable. Unmeasured case-mix variations might account for some of this difference, although specialty does provide a partial adjustment. Nevertheless, the fact that only one of six quality measures is suggestive of poor care in LMPs contradicts the general notion that mills and large Medicaid practices are synonymous.

Credentials, however, clearly separate the LMP physician from his SMP counterpart. In the first discriminant function, we see that LMPs are characterized by their higher proportion of specialists. These specialists tend to be less qualified than those in SMPs, however, in terms of FMG status and board certification. When we define LMPs as at least 50 percent Medicaid (MILL2), they do not differ from other practices in their mix, except for fewer internists. Again, they are less likely to be run by board-certified physicians. The FMG variable is also significant, but with the opposite sign; LMPs, however defined, are run by older physicians without hospital affiliations. Nevertheless, their relative lack of credentials does not qualify them as mill operators; many are undoubtedly running LMPs by default rather than by design. They may be aging general practitioners, for example, who have become isolated in inner-city or rural areas by historical forces, and now serve a primarily low-income population.

TABLE 6

Discriminant Analysis Results for Small Versus Large Medicaid Practices

	Discriminant Functions		Means			
			MILL1		MILL2	
Variables	MILL1	MILL2	SMP	LMP/ELMP	SMP/LMP	ELMP
MDWAGE	0.36***	0.47***	24.34	21.92	24.24	18.22
LOV	0.13	[1]	0.33	0.31	0.32	0.33
TEST	[1]	[1]	35.23	37.12	35.46	38.01
SHOT	-0.75***	-0.40***	17.75	29.65	19.45	30.47
XRAY	[1]	-0.14	14.32	15.73	14.54	15.42
SURG	0.16*	0.19*	4.74	3.89	4.71	2.44
AIDE	-0.24***	[1]	2.11	2.52	2.17	2.43
BOARD	0.31***	0.38***	0.43	0.27	0.41	0.16
FMG	-0.16*	0.31***	0.05	0.11	0.06	0.02
MDAGE	-0.23***	-0.36***	0.29	0.36	0.29	0.46
HOSAFIL	-0.18**	-0.28***	0.01	0.03	0.02	0.05
GS	-0.30***	[1]	0.21	0.18	0.21	0.10
IM	-0.35***	0.19*	0.21	0.26	0.22	0.15
OB	-0.52***	[1]	0.10	0.07	0.10	0.03
PED	-0.11	-0.13	0.08	0.09	0.08	0.12
	λ=0.92[2]	λ=0.94[2]				
	R_c=0.29	R_c=0.24				

[1]F-ratio insufficient for entry
[2]Associated chi-square statistic significant at 1 percent level
*F-ratio significant at 10 percent level
**F-ratio significant at 5 percent level
***F-ratio significant at 1 percent level

High Income LMPs: Are They Medicaid Mills?

The high income ($80,000 or more) LMP (HILMP) comprises 22 percent of all LMPs. Considering the presumably low Medicaid fees HILMPs receive for a large percentage of their patients, how do they manage to enjoy incomes so much higher than other LMPs with similar revenue constraints? Even more puzzling is why their incomes are over 50 percent higher than the average income of a physician operating an SMP when the latter should be receiving higher fees. Clearly, LMP physicians at the tail of the income distribution are either much more productive than the average physician, receiving unusually high fees, generating a much larger number of profitable ancillary services, or they are cutting costs inappropriately. Does this subset of all LMPs constitute the Medicaid mills so often maligned in Congressional testimony? A separate analysis of these practices may shed further light on the behavior of LMPs and the need for specific public action.

HILMPs were originally identified by their conspicuous incomes (greater than $80,000, cost-of-living adjusted). Thus it is not surprising that net incomes in this group are $36,000 higher on average than in SMPs. HILMP incomes ranged from $101,453 for general practitioners to $92,592 for pediatricians. As physician hours do not vary between groups, the imputed hourly wage varies directly with income($37.50 in HILMPs, $24.40 in SMPs). This difference is consistent across all specialties, although insignificant for OB-GYNs.

Are HILMP physicians operating Medicaid mills? They definitely are earning more money than the average physician, both in total and per hour worked. This is true even after adjusting for specialty and training. But simply earning more is not the *sine qua non* of a Medicaid mill. One reason for this greater earning power is geographic location. The majority of the HILMPs are located in States with more generous Medicaid reimbursement levels. On the other hand, HILMP physicians do spend less time with patients, but so do high income physicians with SMPs. If short visit lengths are a sign of mills, then there must be Blue Shield and Medicare "mills" being run by other high income physicians.

What is particularly fascinating are the clear differences in HILMP age, background, and training. It is as if two separate markets exit, one for younger, well-trained U.S. physicians and another for older, less well-trained FMGs. Both groups are able to enjoy high incomes under certain circumstances if they are willing to work very hard in their offices and in the hospitals, if they specialize, and if private payers or Medicaid programs are generous. Because of circumstances, most HILMP physicians are acting more like general practitioners, seeing more patients in more settings, probably filling the void created by the scarcity of younger, better trained, domestic physicians. For their effort they earn an hourly wage comparable to other high income physicians, far above their own credentials and training. A more equal participation rate of younger domestic physicians would presumably reduce both the Medicaid caseloads and incomes of HILMPs through increased competition; either that, or force them to alter their practice style in ways detrimental to patient care.

An Economic Theory of Large Medicaid Practices

A natural question to ask is: "What are the factors behind the decision to operate an LMP?" In this section we develop a theory of LMPs and test it using the data from the 1976 Physicians' Practice Cost Survey.

The origins of LMPs can be considered in terms of a two market demand model (Sloan, Cromwell, and Mitchell, 1978). In one market, the physician is a price-setter: demand is downward sloping and additional visits are demanded only at a lower price. In the second market, fees are predetermined, and the physician serving this market can provide as much as he or she chooses, within limits, at a fixed price. While several insurers have fixed payment schedules, we consider only the fixed payment Medicaid program here.

Assuming revenue maximization for each visit level, the physician moves down along his or her private demand curve, ABE in Figure 2, until marginal revenue falls below the fixed Medicaid fee, f_m. The physician would then begin to participate in the Medicaid program until the pool of Medicaid patients was exhausted. Physicians with supply S"S" would be non-participants, while those with supply SS or S'S' would be running small and large Medicaid practices, respectively, assuming equilibrium between supply and demand.

Thus, the physician's decision to participate in Medicaid as well as the level of participation will depend upon supply and demand. Considerable empirical research has documented the positive effects of health status, income, and insurance on private demand (Feldstein, 1970; Newhouse and Phelps, 1976). Patients should also be willing to pay higher fees to better trained specialists. Holding these factors constant, private demand should be lower (that is, shifted to the left) in physician-rich areas because of competition, as a limited number of patients are spread among a large number of physicians.

Theory predicts that any factor raising (lowering) private demand (for example, income insurance, health status, credentials and specialization, the physician/population ratio) should decrease (increase) the probability of Medicaid participation and the practice being an LMP, all else being equal. Similar predictions hold for an increase in Medicaid fees. Extensions in program eligibility, by contrast, should have more of an effect on the size distribution of Medicaid practices, essentially skewing the distribution toward more LMPs, as SMP physicians simply choose not to serve more of the poor.

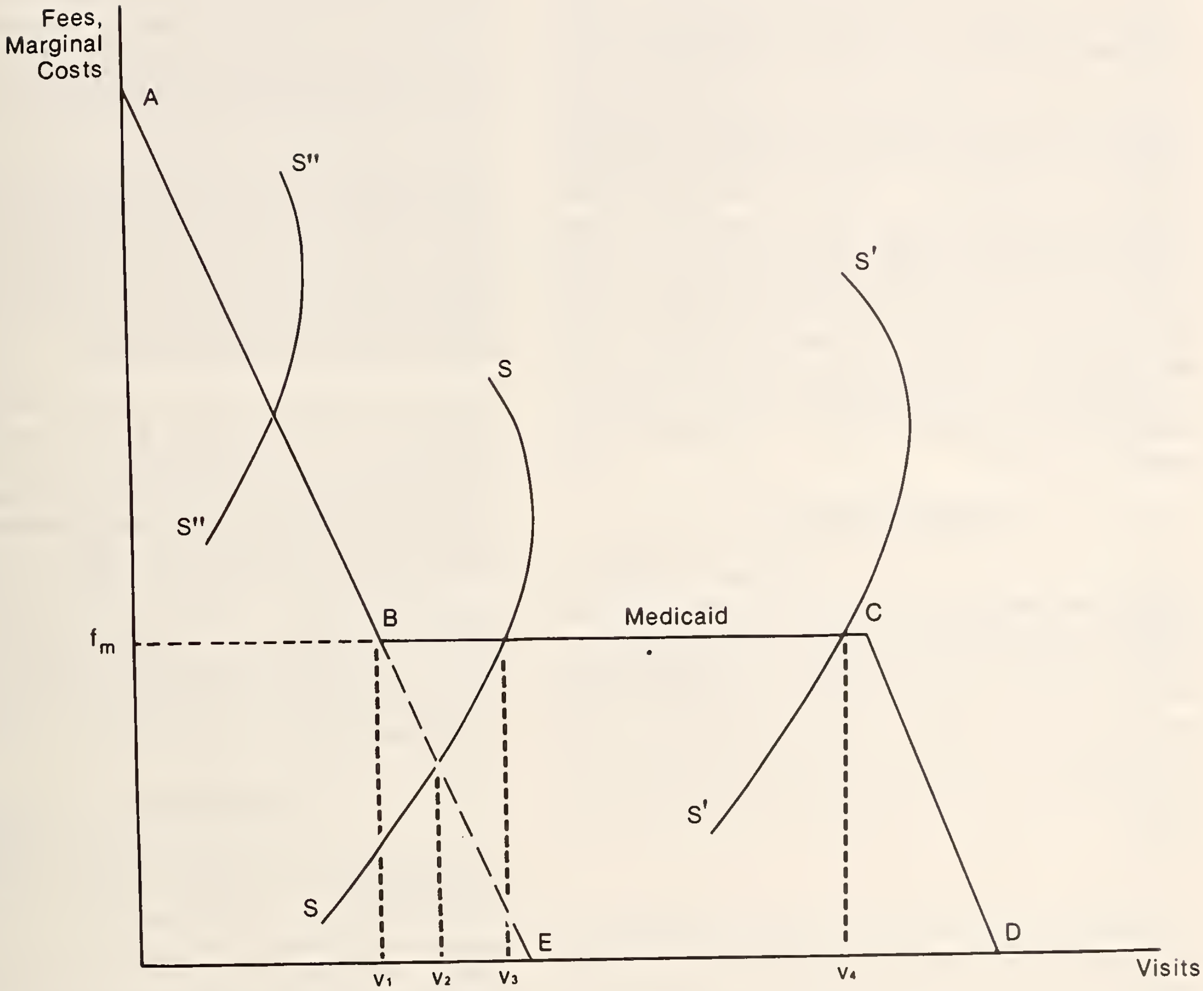
The analysis so far has implicitly assumed physicians do not discriminate among patients on factors other than ability to pay. Some physicians, however, may have a distaste for Medicaid patients or the program as a whole. Some of their reasons may be objective (for example, fee schedules), others more personal. Subjective responses strongly suggest that physicians discriminate against Medicaid patients for one reason or another.

Faced with a stated Medicaid fee, f_m some physicians act as if $f_m(1 - d_i)$ were the *net* fee, where d_i reflects the strength of the ith physician's discrimination coefficient, à *la* Becker (1957). Economic losses to physicians will naturally increase with d_i. In the extreme, where $d_i > 1$, the physician would limit him- or herself strictly to non-Medicaid patients regardless of supply. This does not necessarily mean that the physician is not seeing poor patients. On the contrary, he or she may be seeing many of the poor but just not receiving directly from them as much as if they had been accepted as Medicaid patients.

Within any geographic area, a natural distribution of physician supply curves is likely to be the case, based on the distribution of underlying cost characteristics. The relative number of LMPs depends on the locus of supply *relative* to the private demand-Medicaid fee kink, or the "drop-out" kink (point B in Figure 2). When all practices exhibit supply curves closely bunched around B, Medicaid participation will be zero or quite small while, if they are bunched around point C, most practices will be LMPs.

The locus and distribution of supply will depend on the mean of, and the variance in, the characteristics that underlie physician supply. These characteristics can be broken down into four categories: (1) non-physician input prices; (2) productivity; (3) preferences for income and leisure; and (4) practice style. In areas where auxiliary wages are high, average supply should be less at any given fee, and we would expect the distribution of supply to be shifted to the left. Similarly, where average productivity is low, supply would also be less, as physicians would be financially limited in the visits they could provide for a given fee. Specialists, for example, see fewer patients per hour. Therefore, in specialist-dominated areas, we would expect more limited supply and lower participation rates, all else being equal. If physicians in an area had a higher average preference for

FIGURE 2
A Graphical Model of Medicaid Participation



leisure (for example, older, semi-retired physicians in Florida or Arizona), supply would be less than in areas where work (or income) preferences were stronger. Finally, and most important from a policy perspective, physicians vary in their choice of practice style, partly out of training and specialty choice, partly out of a desire to increase income. Variations in practice style include the time physicians spend with patients, the ancillaries they order, the quantity and quality of labor inputs they use, the size of waiting rooms, and the like.

Given a certain patient case-mix, we should expect considerable variation in ancillary use per patient or per visit, depending on specialty, training, and patient income. Nevertheless, appropriateness "norms," however ill-defined, do exist, and unnecessary use could be measured in theory by a panel of physicians reviewing a physician's case-mix. Physicians who systematically exceed these norms could be considered as inducing ancillary demand beyond the "appropriate" level, presumably in an effort to increase net revenues. Abuse of ancillary services by physicians may be more prevalent in LMPs due to greater consumer ignorance and a zero net price.

Other differences in practice style, like time spent with patients, use of support personnel, and amenities can be characterized as supply shifts. Physicians who see patients on an assembly-line basis and who skimp on needed auxiliary personnel can certainly see more patients per hour at lower incurred costs. The higher net incomes enjoyed, however, come primarily at the patients' expense and would not be condoned by the majority of medical professionals.

Probit Analysis of LMPs

We tested our dual market theory of Medicaid participation and presence of LMPs with probit methods. We specified the dependent variable as a dichotomous variable in which "one" signifies that the physician runs an LMP and "zero" an SMP. Two LMP definitions were used (30 versus 50 percent) in separate contrasts with SMPs. Because the purpose of this analysis was to distinguish solely between large and small Medicaid practices, we omitted non-participants.

Independent variables included proxies for private and Medicaid demand, physician credentials, and supply, as well as regional dummies to capture such unmeasured factors as the level of discrimination and intra-area distribution of physicians. Demand variables included county *per capita* income, an estimate of the county Medicaid population, the office-based primary care physician-population ratio, and two fee variables (the Medicaid routine office visit fee and Blue Shield's allowable fee for the same procedure, the latter a measure of relative generosity of private insurers). Fees, as well as all other monetary variables, were adjusted for area cost-of-living differences. Physician credentials included specialty, board-certification, and FMG status. Physician supply was proxied by physician age (less or greater than 60 years) and a county index of wage rates for non-physician personnel. Presumably, older physicians working in relatively expensive areas would limit supply, thereby reducing their participation levels in less lucrative Medicaid markets. This effect could be offset, on the other hand, by a reduced private demand for older physicians due to attrited (perceived or real) skills.

Empirical Findings

The fee schedule variables were generally insignificant, implying that Medicaid fees have no net effect on the size distribution of Medicaid participants. Evidently, the incentive to expand Medicaid caseloads with more generous fees is offset by the entrance of previous non-participants, leaving the *mix* of SMPs and LMPs unaffected. Higher Blue Shield fees, reflecting an outward shift in private demand, reduce the likelihood of observing an LMP among participants, but only for the 30 percent cut-off point separating SMPs and LMPs.

The specialty parameter estimates are highly sensitive to the definition of LMP used. When defined as practices with 30 percent or more Medicaid patients, specialists are *more* likely to run LMPs. Using a 50 percent cut-off, on the other hand, specialits appear *less* likely to be found in LMPs. It may be impossible for specialists in certain areas to concentrate solely on non-Medicaid patients and still generate sufficient caseloads. Because of their skills, they may also be morally bound to treat a certain number of Medicaid patients. Hence, we find a surprisingly large percentage of specialists running reasonably large Medicaid practices.

What kinds of specialists are seeing large numbers of Medicaid patients? Apparently those that are less often board-certified. They are also more likely to be FMGs, although this depends again upon the definition of an LMP. We do not know why FMGs are significantly less likely to be running ELMPs. Physician age is positive in both probit equations: older physicians appear more than willing to offset falling private demand with increased supplies of Medicaid visits.

Variations in public and private demand have the expected impacts on physician participation levels. In higher income areas, physicians supply more private visits and thus maintain smaller Medicaid practices. When public demand is high on the other hand, as measured by a large Medicaid-eligible pool, physicians are willing to supply more Medicaid visits and operate larger Medicaid practices, essentially being reimbursed at Medicaid levels rather than having to provide low cost or *pro bono* care to the uninsured poor.

The probability of a physician running an LMP is greatly increased in physician-dense areas, however. This is particularly important for policy purposes, for it suggests that physicians will respond to increased competition in the private market by supplying more and more visits to Medicaid patients. Some of this care may be unnecessary, though, resulting in negative competition effects.

Finally, the regional dummy variables indicated strong geographic variations in LMPs, above and beyond those captured by other variables. The South has a higher proportion of LMPs among participating physicians overall, while the West and Northeast exhibit higher proportinos for LMP > 30% and LMP > 50%, respectively. Region may proxy non-maximizing behavior such as discrimination and dislike for public welfare programs, which would discourage "potential" SMP physicians from participating and raise the LMP/SMP proportion. It may also reflect mismeasurement of other important independent variables like fees and Medicaid coverage.

Conclusions

Exceptional cases of fraud and abuse in inner-city LMPs have prompted an investigation of LMPs nationally. The large percentage of Medicaid *patients* in LMPs has reinforced concern over the quality of care in such settings, and rightly so, since nearly 60 percent of all Medicaid patients receive care in them (at least 30 percent Medicaid). Even if a small proportion of these LMPs are mills, a large number of Medicaid patients will be affected by care received there because Medicaid patients are so unevenly distributed.

As for LMPs altogether, there is no evidence that mills are a significant factor. Visit lengths are shorter in LMPs, but only by a minute or two. Nor is there widespread abuse of ancillary services, skimping on auxiliary personnel, or excessive markups over costs. LMP physicians at best average what other physicians make; usually earnings are less. Contrary to the stereotype, most LMPs are not found in large, urban ghettos, but rather, in small cities, in rural areas, and in the South. The background and training of LMP physicians is generally inferior, however; the physicians tend to be older, less specialized, with fewer credentials (for example, less often board-certified), and more frequently trained in foreign medical schools. If our theory is correct that the Medicaid program and its beneficiaries constitute a secondary, residual market, subordinate to a better insured, primary market, then competition will drive less qualified physicians into the Medicaid program in disproportionate numbers. A primary goal of the public benefits programs to integrate the poor into mainstream medicine is thereby

thwarted. Many of the poor, of course, are receiving office-based care for the first time, and access has thereby improved, but it is by no means equal. The Medicaid patient has a much higher probability than the Blue Shield or even Medicare patient of being treated by a less qualified physician.

Because of the Moss investigations, LMPs have been subject to a blanket criticism, which essentially makes serving the poor a disreputable occupation. Exposes may discourage illegal behavior, but they may also have the unintended side effect of discouraging physicians from expanding their practices in underserved areas. Current fraud and abuse activities, furthermore, do not address the credentials gap since they focus only on the over-utilizers. Program reform, on the other hand, should improve both access and quality of care, as more qualified physicians are attracted to the Medicaid market, providing the poor with an alternative to Medicaid mills.

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Comments

by Philip J. Held, Ph.D., Urban Institute

I think the paper by Frank Sloan goes a long way toward extending use of these data beyond the original intent. It obviously addresses important issues due to the prominent market position of Blue Shield plans.

I will avoid restating what Sloan reviewed. Instead, I will make some general comments on the technical approach and then more extensive comments on the implications for policy.

The first question Sloan asks is: Does the fact that physicians have active control of Blue Shield boards and the like lead to higher payments per procedure? The answer appears to be yes. His second question is: Are physicians more willing to participate in Blue Shield plans when they have active control over the boards? Although the answer is again yes, I would qualify it by adding a "maybe." Before discussing these conclusions, however, I would like to review a few technical points.

Out of a maximum 69 Blue Shield plans, 29 were represented by the sample of physicians used in this study. If each of these 29 Blue Shield plans had a single fee schedule, there would only be 29 degrees of freedom in the dependent variable, even though 800 physicians were observed. Apparently Blue Shield fees within a given area do vary for a given procedure. I was somewhat concerned about this since the variation in the dependent variable is probably a lot less than would be indicated by the sample of 800 doctors. In designing future studies of this type, the issue is how you might ensure broader representation of the Blue Shield plans and identify the true degrees of freedom for the dependent variable.

Second, I thought that the quantification of the physician involvement in Blue Shield was very good. For this, Sloan indicated four different measures: physicians' control of selecting board members, the proportion of board members who were physicians, their degree of control over special Blue Shield committees, and Medical Society approval of the plans.

Let me now return to the policy implications of this research. The analysis potentially indicates that greater physician control or involvement in Blue Shield boards is liable to lead to higher costs. Secondly, it suggests that more involvement by physicians in Blue Shield plans leads to some reduced participation by these physicians in other sub-markets, such as Medicaid. In addressing these issues Sloan focused on how much Blue Shield paid for a given procedure, whereas I would argue that the relevant price is the average price in the market area and not just Blue Shield's price.

Sloan points out that it has never been shown empirically that the control of Blue Shield plans affects the average price. However, he does develop a theoretical argument that if physician control of Blue Shield plans leads to higher prices for Blue Shield services, higher average prices in the market area should result (since Blue Shield is a subset of the entire market). Sloan does not discuss, however, the possible effect of market "sorting" by Blue Shield and other insurance plans.

Let me expand on this issue. It could be that, in the communities where Blue Shield fee levels are high, physicians are more willing to serve on the board. In other words, there may be reverse-causation. Such a condition could lead to a sorting effect such that the average fee across all communities is not affected. It is just that in some communities, Blue Shield fees are high, inducing physicians to participate in plans, while in other communities where Blue Shield fees are low, they do not. It is possible that the average price within two such markets is the same. The issue for policy is how much does physician influence over Blue Shield prices affect the average price across all areas, not just the Blue Shield price. This issue is not answered by this paper.

There is another policy issue which I wish had been developed, but it is probably beyond the scope of this project. What are the social implications of Blue Shield's tax status, a status which provides Blue Shield plans with a competitive advantage over other health insurers? The economists' view is that severing the link between the Blue Shield boards and physicians may not improve social welfare, since there would still be rents which accrue to the Blue Shield plans through their tax advantage. As Sloan mentioned, what Blue Shield does with the rents is another issue. That is, even if the link between physicians and Blue Shield were severed, rents might still accrue. The only difference between physician ties to Blue Shield plans and no ties is whether rents would accrue to physicians or to the Blue Shield plans.

Lawyers take a different approach concerning the competitive advantages enjoyed by Blue Shield. For lawyers, a policy issue is the publication of Blue Shield's fee schedules, which permit the foundation of a cartel in a substantially different way than would exist without fee schedules. Again, cutting physician links to Blue Shield boards may not affect this tendency, although severing these links might not do any social harm, either.

Lastly, there is the issue of interaction of markets. Sloan indicated that it is now well established that relative fees affect physician willingness to participate in public insurance plans. That is, if Blue Shield fees are increased, Medicaid patients become less desirable financially and, consequently, physicians shift away from Medicaid patients. I think the research community has had an influence in policy circles in this regard, and it is now accepted that prices do seem to matter and that physicians respond in their willingness to take patients. But maybe we have gone too far in the sense that, to date, we have not really established what

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happens to Medicaid patients as a consequence of changes in fee schedules. For example, how severe is the welfare loss resulting from changes in relative prices? If the Medicaid fee level is reduced relatively, perhaps as a consequence of Blue Shield fee increases, is it possible that some physicians will concentrate on treating Medicaid patients? Would such a situation involve a welfare loss to patients? How much of a loss would there be? These issues are currently unanswered.

Unfortunately, this leaves me only a few minutes to review Janet Mitchell and Jerry Cromwell's paper, which I found to be very enjoyable and informative. It is easy to read and it comes to the point. It reminds me of Stuart Altman's old story about how in Washington there are two groups: lawyers and economists. The difference between the two is that economists have numbers. But there are a few rules about using numbers in Washington. The first one is that people do not care where the numbers come from. The second rule is that if you ever circulate a number and you subsequently follow it up with another number, make sure the two agree.

I think there have been many instances in Washington of numbers and stories about Medicaid mills and the like that have been circulated but not substantiated. The Mitchell-Cromwell paper should certainly make one suspicious of the allegations regarding widespread abuse of the public by Medicaid mills.

The Mitchell-Cromwell paper tests many hypotheses about medical practices which have a large proportion of Medicaid patients. In general, the common wisdom about excessive ancillary tests, fewer staff per patient, and other allegations regarding abuse in practices with a high proportion of Medicaid patients is not supported by the data. This paper is not complex or technical but is to be commended for its directness, relevance, and readability.

Comments

by Marsha Gold, Sc.D.,
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The findings of both the Sloan paper and the Mitchell and Cromwell paper are provocative. Discussing each in turn, I would like to begin by reiterating a few of the important points in the Sloan paper and discussing some of the policy implications.

As Sloan discussed, his research suggests that when physicians have formal control of Blue Shield decision-making, Blue Shield payments are higher. On balance, this should cause some public concern. Increases in Blue Shield payments may raise the overall costs to the public, making it harder for public patients and people with limited resources to obtain care.

Sloan's research also suggests that higher Blue Shield payments may lead to benefits for Blue Shield subscribers by reducing their out-of-pocket expenses as a result of an increase in physician participation rates. However, I urge some caution on this argument. It is possible that Blue Shield payment levels and physician participation rates are, to some extent, jointly determined by the same dynamics that lead physicians to control Blue Shield organizations. In addition, it is conceivable that higher Blue Shield payments lead physicians to raise overall fee levels. This may lead to situation where Blue Shield-covered persons whose physicians do not choose to participate in the plan incur out-of-pocket liability which is at least equal to their counterparts in the commercial insurance sector.

Sloan's results will undoubtedly lead to controversy, and the methods he used will come under some criticism. Some caution on use of the data is justified, as there are acknowledged limitations to the analysis. However, I would like to highlight something that I find particularly significant—the consistency of the results of Sloan's work and the work undertaken by Kass and Pautler for the Federal Trade Commission (FTC).[1]

These studies used different data bases and took different approaches to the subject. The FTC research focused on maximum reimbursements in each Blue Shield plan. It examined how physician control of Blue Shield plans affects the customary or the maximum allowable reimbursement for physicians in each Blue Shield plan throughout the country. The results suggest that physician control is associated with significantly higher physician fees. Sloan's work focused on a national sample of physicians who practice in areas served by 27 plans. It examined how physician control influences the actual reimbursement for various procedures. The Blue Shield Association has been critical of the FTC work, particularly for its reliance on maximum allowable charges rather than actual physician charges or payments. Sloan's research suggests that physician control will lead to higher reimbursed prices, regardless of how price is measured. This is a field where doubts linger, and almost any research has limitations. I do not think we have the total answer. However, I am impressed when different studies, using different techniques, come up with similar results.

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[1] David I. Kass and Paul A. Pautler, "Staff Report on Physican Control of Blue Shield Plans (Washington, DC: Federal Trade Commission, Bureau of Economics, November 1979)

In June of 1978, former HEW Secretary Joseph Califano proposed that a majority of all organizations that pay claims for Medicare and Medicaid be controlled by consumers or representatives of the public. The intent was to ensure that those with a financial stake in the health care industry do not dominate the organizations that process and pay bills for public programs. Although the final status of the proposal has yet to be determined, I think that it is indicative of the implications Sloan's results may eventually have for the Department.

In particular, the issue of provider domination of payers is likely to be important in structuring a national health insurance program. This task requires a consideration of which types of organizations will serve as administrative or fiscal agents and what constraints will be placed upon their composition, structure, and governance. If we are to effectively tackle these questions, I think it is very important that we get beyond the aggregate numbers and look at the dynamics of what is going on. Other research funded by HCFA, such as that of William Hsaio at the Harvard School of Public Health, has been developing case studies of Blue Shield organizations and commercial insurers. This and other research will provide better information on the comparative role and performance of these two types of organizations.

I also think the issue of monopsony power, where you have one buyer and numerous sellers, needs to be explored. Because of their advantageous position, and for other historical reasons, many Blue Shield organizations cover substantial proportions of the insured population. It is possible that the Blue Shield plan may use the power of its market position to reduce reimbursements, potentially controlling costs. Further research on this issue would be useful to determine the relationship if any, between market share, physician control, and reimbursement levels.

I would like to turn now to the paper by Mitchell and Cromwell, to emphasize and elaborate on certain of their points. The work is reassuring on some points and disturbing on others. Physicians with large Medicaid practices generally did not receive higher incomes than physicians with smaller Medicaid practices. In fact, it seems more typical, from the data, that physicians with large Medicaid practices receive less income and lower net revenue per visit than they would have received had they seen the same number of private patients. Care provided by physicians with large Medicaid practices is not that blatantly or consistently different in many respects from care provided by physicians with small Medicaid practices.

Since it is very easy to look for the extreme cases of abuse and think that they are extensive, this study is important. It suggests that public programs to provide coverage to disadvantaged populations can work, and that flagrant abuse is apparently not widespread. In light of pending legislation on the Hill for national health insurance and for expanded coverage for low income children, I find these results positive.

What is disturbing are some of the more detailed results Mitchell emphasized. These show that about a third of all Medicaid patients are seen by roughly 5.5 percent of physicians, indicating that a sizeable proportion of the Medicaid population still may not receive the same care—or care from the same sources—as does the rest of the population. For example, although the data do not indicate major differences in the care provided in large and small Medicaid practices with respect to laboratory and radiology procedures, the physicians in large Medicaid practices provided more injections and slighter shorter visits. The evidence also indicates that physicians with large Medicaid practices provided fewer visits in inpatient settings and more visits in hospital outpatient departments and emergency rooms. Particularly disturbing was the finding that physicians with large Medicaid practices generally had fewer credentials. These results should be viewed cautiously. Case-mix could not be adjusted for, the data are self-reported by physicians, and the focus was on a total physicians' practice—not on the treatment of individual patients or Medicaid patients only.

While recognizing limitations, however, these data do raise the concern that fragmented and poorer quality care may exist for sizable numbers of Medicaid patients. At a minimum, they provide evidence that two systems of care, separate though perhaps equal, may exist. If one of our objectives is to provide the disadvantaged with access to the same care as the rest of the population, these findings suggest we still have a way to go. What then are the implications for policy?

Results indicate that higher Medicaid fee levels may not shift physicians from small to large Medicaid practices. However, prior research from last year's survey indicates that physician participation in Medicaid is highly sensitive to the level of Medicaid fees—both in an absolute sense and relative to other insurers. That research also included physicians not participating in Medicaid and a more complex fee variable and model structure. The findings are supported by other studies. The results suggest that present efforts to raise Medicaid fees relative to those of Medicare and private insurance should expand physician participation in Medicaid. This should reduce dependence of the Medicaid population on a small segment of physicians. In this vein, it is relevant to note that the Carter Administration's proposed national health insurance plan integrated the Medicare and Medicaid plans so that Medicaid fee levels would have been raised to Medicare level.

Financing *per se* may be only a partial solution to the problems of obtaining access for the disadvantaged to mainstream medical care. Undoubtedly, some of the patterns of Medicaid participation reflect the present distribution of physicians, which several of our present policies are trying to change. These include efforts to foster both primary care specialization and the location of both physicians and services in medically underserved areas.

However, the goal of integrating the poor into mainstream medicine may require more than concern with financing or distribution. There is some evidence that certain physicians have a distaste for Medicaid or poorer patients—or for other reasons do not serve as an alternative source of medical care to the Medicaid populations near them. Perhaps we need to consider whether it is appropriate for private physicians—whose education has been heavily subsidized by the public—to act in this fashion. In any case, we can consider how such behavior might be altered.

In conclusion, Mitchell and Cromwell's research suggests that large numbers of Medicaid mills probably do not exist, but the poor still have a way to go before they obtain equal access to mainstream medical care.

Physician Productivity and Remuneration Method

by Robert S. Woodward and Frederick Warren-Boulton

This paper develops a theoretical model to examine physician behavior under alternative reimbursement schemes. It considers three alternatives: (1) a system in which a physician's income is fixed at a certain level regardless of his/her practice activities; (2) one in which income is proportional to the production of medical care; and (3) one in which income is proportional to time spent in patient contact. These are labeled fixed, output-based, and time-based incomes, respectively.

The microeconomic model reported in the paper generates a number of unambiguous results in terms of income and utilization of practice inputs for these different types of income. These results form a solid foundation for predicting the effects of the more complicated real-world remuneration systems.

By assuming that fee-for-service remuneration is at least partly based on medical care produced and that salary remuneration is in part a fixed remuneration, the author derives hypotheses of less income, less time at work, and lower work expenditures for salaried physicians. Data from the 1976 Physicians' Practice Costs Survey support the hypothesized predominance of output-based incomes and the anticipated lower earnings and practice expenses of fixed income physicians.

The author also reports that the induced demand hypothesis is not refuted by the HCFA survey data and that female physicians earn significantly lower incomes than their male counterparts.

Introduction

In 1978, physicians received $5.5 billion from Medicare and $1.1 billion from Medicaid (Gibson, 1978). As administrator of these Federal funds, the Health Care Financing Administration (HCFA) has a mission to "promote efficiency and quality within the health delivery system." Indeed, "reform and control of reimbursement" to improve quality, increase access, and hold down costs have been key HCFA priorities (HCFA, 1979).

The objective of this research is an increased understanding of one aspect of reimbursement, physician remuneration methods. The central role of physicians in determining all medical care expenditures is well recognized (Evans *et al*, 1973; Fuchs, 1974). Yet the implications of different types of doctors' incomes are imperfectly understood. We seek to explain how alternative remuneration methods (not dollar amounts) affect physicians' income and use of practice inputs.

Different physician remuneration methods are of particular interest because they afford the prospect of generating quality and cost improvements through decentralized market incentives. Direct regulations are increasingly criticized for their unanticipated long-term cost increases and perverse economic disincentives. Specifically, alternative physician remunerations offer the possibility of achieving the cost containment objectives of the Economic Index without the potential hazards of direct regulation.

Physician remuneration methods have some effect on physician productivity and use of resources. In prepaid group practices, there are substantially lower hospitalization rates, which lower the combined out-of-pocket and premium costs by 10 to 40 percent (Luft, 1978). But the cost reductions do not occur in foundation HMOs and are affected by

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the risk assumed by the physician and by peer review (Gaus *et al*., 1976). Perkoff (1976) finds that HMO costs are not uniformly lower than equivalent fee-for-service expenditures.

Conventional wisdom also recognizes the potential effects of new alternative remunerations. Recent suggestions for alternative remuneration methods include scrapping the Medicare formula because of its inflationary impact (Dwyer, 1978) and the Institute of Medicine's suggestion of paying equal fees to specialists and primary physicians (Estes *et al*, 1978).

Despite empirical estimates of overall expenditure savings *per capita* and the attention directed to alternatives to fee-for-service remuneration, neither theoretical models nor empirical tests have examined physician productivity or detailed resource utilization as a function of alternative remuneration methods. In their path-breaking works, Evans (1976), Feldstein (1970), Glaser (1970, 1976), and Pauly (1970) have cited the importance of physician remuneration methods. Nevertheless, there is a need for more rigorously-specified physician models which can verify, or at times challenge, intuition.

The well-known economic models are not capable of simultaneously demonstrating the effects of a broad range of remuneration methods. The best-known (income-leisure) model, an allocation of time between leisure and earning income, ignores the importance of practice inputs and cannot distinguish between fixed and output-based incomes. The profit maximization model ignores physicians' interests in leisure time and cannot compare time-based and fixed incomes.

Modifications of these basic models and subsequent applications to non-physician behavior have appropriately identified the key issue but have not generated testable hypotheses. Because the pioneering work by Cheung (1968) and Olsen (1976) uses the basic income-leisure model, the authors conclude that the method of remuneration should have no effect on sharecroppers' use of resources or productivity. Stiglitz (1974, 1975) does find remuneration method important because sharecropping forces the tenant to assume some of the risk of the uncertain crop production. However, neither this "risk aversion" nor "work effort" (Olsen, 1976; Pencavel, 1977) is an observable factor which may be expected to generate testable hypotheses.

This paper examines the effects of remuneration alternatives on patient care in the context of a model which integrates features of both the income-leisure and the profit maximization models. In a manner similar to the income-leisure model, physicians are assumed to derive satisfaction from both work and leisure activities. In a fashion similar to the profit maximization model, earned income is presumed to be spent on both work and leisure.

The analysis proceeds as follows. In the next section, we define a set of conceptual and a set of empirically observable remuneration alternatives. In Section III we introduce and solve our microeconomic model of physician work and leisure activities. In Section IV, we introduce and analyze data from the 1976 Physicians' Practice Costs Survey to estimate the effects of alternative remunerations on the use of certain practice inputs.

Alternative Remunerations

This research considers the effects of two groups of remuneration alternatives. The first is a set of three conceptually pure remunerations. The second is a group of real-world alternatives.

The three alternatives in the former set are incomes which are fixed, regardless of the physician's activities, incomes which are proportional to the physician's production of medical care, and incomes which are proportional to his or her patient-contact time. We call these fixed, output-based, and time-based incomes, respectively. The microeconomic model developed and reported in the next section generates a number of unambiguous income and practice input results for these different types of incomes. These results form a solid foundation for predicting the effects of the more complicated real-world remunerations.

The transition from the conceptually pure set to the set of real-world remuneration alternatives is not straightforward. The well-known fee-for-service remuneration does not exactly correspond to either time- or output-based income. For example, Dr. Esselstyn cites the similarities between fee-for-service and output-based income (1978). In contrast, Dr. Hughes has reported the high correlation between the units of the California Relative Value Scale and surgeons' time inputs (1979). Similarly, salary incomes are to some degree fixed, yet depend upon (or may require a certain amount of) the physician's work time. Salaries may even have some relation to a physician's expected productivity.

For the purposes of the transition from the conceptual to the real-world, we presume that the fees of a fee-for-service system are determined by both the physician's time and by the medical care he or she produces. Similarly, we assume that salary is some mix of fixed income and time-based income.

While these definitions do capture some of the key remuneration characteristics which will affect physician behavior, they are not presented as more than useful characterizations. One qualification which is particularly evident is that a physician receiving a salary is an employee, while a physician paid fees for his or her services is more like an independent contractor. The income of salaried employees is less affected by fluctuating demand. The practice inputs of salaried employees are significantly determined by an employer.

Despite this qualification, the microeconomic modeling has policy relevance and is more than a pedantic exercise. Exactly because the real world remuneration methods are not straightforward, we need to understand the separate effects of each characteristic of the real world. As the administrator of public expenditures on medical care, HCFA needs to thoroughly understand the effects of physician remuneration on delivered medical care. The model presented below develops one important component of that understanding: a conceptual model of physican work and leisure decisions. Such an exercise is useful to HCFA because it develops the logical consequences of a series of reasonable assumptions. These assumptions and their consequences then become a standard by which actual remunerations and empirical observations may be compared.

Physician Work-Leisure Model

Our model presumes that each physician derives utility from professional activities, measured by medical care production V, and from the consumption of the product of leisure activities Z.

(1) $U = U(V,Z)$

where U is utility level,
V is total production of medical care,
z is total production (and consumption) of leisure activities,

$U_v \geq 0$, and $U_z < 0$.

The use of production of leisure activities rather than leisure time and net income in the utility function follows Becker (1965). Our assumption that a doctor derives satisfaction from his or her professional activity, measured by production of medical care, is less common. Scitovsky recognized the issue in 1951.

> Artists, scientists, professional people, and business men often regard their work not merely as a means of earning income but as an important and interesting part of their lives.

More recently Enthoven has defined physicians' joint objectives.

> Physicians and other health professionals are motivated by non-financial goals, including a desire to cure the sick and to achieve professional excellence and esteem of peers and public. But their use of resources is inevitably shaped by financial incentives (1978).

Our model includes medical care output in the utility function as a direct representation of the first of Enthoven's professional objectives. Demonstrating exactly how financial incentives can shape physicians' use of resources is the main focus of the research.

An exact definition of the medical care output V is unnecessary for this conceptual research. The usual empirical indexes of physicians' production, such as patient contacts or billings, are simply not good measures of changes in patients' health. Although health status indexes ask the relevant questions, they are inadequately developed to be generally useful. In this theoretical section, medical care output V is assumed to be some undefined combination of improved patient characteristics, such as increased longevity, reduced pain or suffering, and increased psychological satisfaction. The purposes of this conceptual model are satisfied by assuming only that each physician behaves as if he or she understands the definition of medical care.[1] In the later empirical sections we adopt the usual empirical output measures.

In a manner identical to Becker, we assume that physicians produce leisure using consumer purchases x_z and their own time t_z.

(2) $Z = Z(x_z, t_z)$

where Z is production of leisure activities,
x_z is purchased consumer goods,
t_z is leisure time,
$Z_{x_z} > 0$, and $Z_{t_z} > 0$.

Of course, one of Becker's leisure activities could easily be producing medical care. By using such a specification, we have the physician's work production function where medical care V is produced using intermediate market goods x_v and the physician's time t_v.

(3) $V = V(x_v, t_v)$

where V indicates the quantity of work (medical care) produced,

x_v are quantities of practice inputs purchased with income,

t_v is the physician's time at work

$V_{x_v} > 0$, and $V_{t_v} > 0$.

The use of practice inputs in the medical care production process is taken from the profit maximizing model of physician behavior. Physicians' practice inputs include office space, equipment, and medical and non-medical personnel.

[1] We assume that the marginal rate of technical substitution between quality and quantity levels is unaffected by remuneration method. all else being equal.

The physician's behavior is constrained by income and by the time allocated between work and leisure. The income and time constraints are

(4) $Y = x_v + x_z$ and

(5) $T = t_v + t_z$

where Y indicates gross physician real earnings, that is gross dollar earnings divided by the price of goods.[2]

x_v is purchases of practice inputs.

x_z is purchases of consumption goods for leisure purposes.

T is total time,

t_v is time at work, and

t_z is time spend on leisure activities.

In the context of this model, we consider three overly simplistic remuneration alternatives.[3] Because our two empirically-observed remuneration alternatives do not correspond directly to any of the simple remuneration alternatives, we adopt the use of the somewhat pedantic "fixed," "time-based," and "output-based" terminology. Later in the paper we shall derive empirically testable hypotheses from the assumption that salaries consist of a combination of time-based and fixed incomes and that fees-for-services are combinations of time and output-based remunerations.

The simplest income is fixed; the physician receives a predetermined remuneration per time period regardless of his or her activities during that period.

(6) $Y = Y_f$

where Y_f is exogenously determined.

Time-based income is a second remuneration method, although physicians are not frequently paid directly proportionately to their hours at work.

(7) $Y = wt_v$

where w is an exogenous wage rate.

Output-based remuneration refers to an income based on the treatment of specific conditions such as normal delivery or New Jersey's experiment with payments based on a large number of standardized "diagnosis related groups." Such remuneration is fixed per unit of output regardless of the physician's time or use of any practice inputs.

(8) $Y = PV$

where P is an exogenously determined price per unit of health care output.

The general Lagrangian expression (which allows us to maximize physician's utility subject to two constraints) for this work-leisure model is

(9) $£ = U[Z(x_z, t_z), V(x_v, t_v)] + \lambda_t(T - t_z - t_v) + \lambda_x(Y - x_z - x_v)$

Mathematical Solutions to a Cobb-Douglas Model

The following Cobb-Douglas model with constant returns to scale has been solved for fixed, time-based, and output-based remunerations.[4]

(10) $U = Z^{\gamma} V^{(1-\gamma)}$

(11) $Z = t_z^{\alpha} x_z^{(1-\alpha)}$

(12) $V = t_v^{\beta} x_v^{(1-\beta)}$

(13) $T = t_z + t_v$

(14) $Y = x_z + x_v$

The Lagrangian for this model is

(15) $£ = t_z^{\gamma\alpha} x_z^{\gamma(1-\alpha)} t_v^{(1-\gamma)\beta} x_v^{(1-\gamma)(1-\beta)}$

$+ \lambda_t(T - t_z - t_v) + \lambda_x(Y - x_z - x_v)$

where $Y = Y_f$, $Y = wt_v$, or $Y = PV$.

Solutions to the utility maximization model for each of the three remunerations are obtained by taking the first partial differentials of the Lagrangian for each of the six dependent variables, setting each of those equations equal to zero, and solving the six equations for each of the dependent variables. The six first order equations for the three remuneration alternatives are reported in Appendix I.

The general solutions for each of the six endogenous variables, income, and unit-cost of medical care are presented in Table 1. By definition of the Lagrangian first order conditions, each of these solutions indicates how the model's parameters would determine each variable where the physician achieved the maximum utility possible given his or her limited amount of time and the remuneration method.

One remarkably strong result is immediately apparent. Because our functional form is Cobb-Douglas, the allocation of time between work and leisure is determined only by the total time available, T, and the parameters α, β, and γ. The amount of income and, in some cases, the kind of income have no effect on the time allocations. In all three remuneration types, the time at work and the time at leisure have no parameters which reflect the level of income.

[2]We assume that consumption goods x_z and practice inputs x_z have been normalized so that their prices are equal, $p_{x_v} = p_{x_z}$.

[3]A fourth alternative, capitation or prepayment, is excluded from this paper for the lack of accurate empirical measure of those physicians who accept capitation payments.

[4]While the Cobb-Douglas functional forms significantly simplify the algebra, they may also introduce results which would not be robust for other functions. The implications of relaxing the unitary elasticity assumptions will be considered in future research.

TABLE 1:

Endogenous Variable Solutions for Three Remunerations (Cobb-Douglas Model with Constant Returns to Scale)

Endog. Var.	Fixed Income		Time Based Income		Output-Based Income
t_z	$\frac{\alpha\gamma T}{\alpha\gamma + \beta(1-\gamma)}$	$>$	$\alpha\gamma T$	$=$	$\alpha\gamma T$
t_v	$\frac{\beta(1-\gamma)\, T}{\alpha\gamma + \beta(1-\gamma)}$	$<$	$(1-\alpha\gamma)\, T$	$=$	$(1-\alpha\gamma)\, T$
x_z	$\frac{(1-\alpha)\gamma Y}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)}$		$\frac{(1-\alpha)\gamma}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)} (1-\alpha\gamma) wT$		$\frac{(1-\alpha)\gamma\beta}{(1-\beta)}\; T\,[P(1-\alpha\gamma)]^{\frac{1}{\beta}} \left(\frac{1-\beta}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)}\right)^{\frac{1}{\beta}}$
x_v	$\frac{(1-\beta)(1-\gamma) Y}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)}$		$\frac{(1-\beta)(1-\gamma)}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)} (1-\alpha\gamma)\, wT$		$T\, P^{\frac{1}{\beta}} (1-\alpha\gamma)^{1+\frac{1}{\beta}} \left(\frac{(1-\beta)}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)}\right)^{\frac{1}{\beta}}$
Y	Y		$(1-\alpha\gamma)\, wT$		$T\,[P(1-\alpha\gamma)]^{\frac{1}{\beta}} \left(\frac{(1-\beta)}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)}\right)^{\frac{1}{\beta}-1}$
Z	$\left(\frac{\gamma\alpha T}{\alpha\gamma + \beta(1-\gamma)}\right)^{\alpha} \left(\frac{\gamma(1-\alpha) Y}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)}\right)^{1-\alpha}$		$(\alpha\gamma T)^{\alpha} \left(\frac{(1-\alpha)\gamma(1-\alpha\gamma)\, wT}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)}\right)^{1-\alpha}$		$(\alpha\gamma T)^{\alpha} \left\{ \frac{\gamma\beta(1-\alpha)T}{(1-\beta)} \left[\frac{P(1-\alpha\gamma)(1-\beta)}{(1-\beta) + \gamma(\beta-\alpha)}\right]^{1/\beta} \right\}^{(1-\alpha)}$
V	$\left(\frac{\beta(1-\gamma)\, T}{\alpha\gamma + \beta(1-\gamma)}\right)^{\beta} \left(\frac{(1-\beta)(1-\gamma) Y}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)}\right)^{1-\beta}$		$\left[(1-\alpha\gamma)\, T\right]^{\beta} \left(\frac{(1-\beta)(1-\gamma)(1-\alpha\gamma)\, wT}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)}\right)^{1-\beta}$		$T\,(1-\alpha\gamma)^{1/\beta} \left(\frac{(1-\beta)\, P}{(1-\beta) + \gamma(\beta-\alpha)}\right)^{(1/\beta)-1}$
$\frac{Y}{V}$	$\frac{[\alpha\gamma + \beta(1-\gamma)]^{\beta}\, [(1-\alpha)\gamma + (1-\beta)(1-\gamma)]^{1-\beta}\, \gamma^{\beta}}{(1-\gamma)\beta^{\beta}(1-\beta)^{1-\beta}\, T^{\beta}}$		$w^{\beta}\left[1 + \frac{(1-\alpha)\gamma}{(1-\beta)(1-\gamma)}\right]^{1-\beta}$		P

In this constant-returns-to-scale model, the physician's allocation of time is identical for both wage and output-based incomes.[5] Moreover, physicians whose income is fixed should spend less time at work than physicians whose income is determined by their production of their time at work.

Three Alternative Dynamic Markets for Physicians' Services

Comparisons of the magnitudes of the remaining endogenous variables are not possible without additional information. Physicians' incomes, productivities, and use of practice inputs depend upon the dynamic characteristics of the market for physicians' services. We consider three extreme alternatives and then derive strong conclusions where the market alternatives do not affect the impact of remuneration type on the endogenous variables. The detailed rankings are reported in Table 2.

The "equal utility" assumption describes a market which would exist if physicians were sufficiently mobile between remuneration methods to force the market to adjust the "prices" of physician services (Y, w, and P) to leave physicians at an equal utility level. This market implies that purchasers bear the entire cost burden of any inefficiencies generated by remuneration methods which are less than ideal.

The "equal income" assumption describes a market where physicians would earn equal gross income under each remuneration method.[6] This equilibrium could be generated by an omnipotent third-party payer who was able to adjust the remuneration rates to equalize physicians' gross incomes. This implies that physicians on fixed incomes do better (have higher utility levels) than their more efficient, output-based income counterparts. Therefore, patients of fixed-income physicians face even higher relative unit costs than they face under the equal physician utility assumption.

The "equal cost" assumption describes a market where physicians are assumed to accept a fixed unit cost level regardless of the type of remuneration. This type of market implies that patients are aware of the costs of medical care, choose physicians on that basis, and are indifferent to how the physicians are paid. In such a market, physicians absorb all costs associated with inefficient production generated by sub-optimum remuneration methods.

Despite the different market assumptions, the rankings of endogenous variables are remarkably similar. In addition to the already reported determinancy of the time allocations, the rankings of leisure activities, medical care production, and unit costs are unaffected by whether utility or gross income is assumed equal between remuneration methods. Leisure activities are greatest under a fixed income, intermediate for time-based income, and least for output-based income.

Conversely, the production of medical care is greatest for output-based income, intermediate for time-based income, and least for fixed income. The per unit cost of medical care production is least for output-based income, intermediate for time-based income, and greatest for fixed income.

The physicians' use of practice inputs is affected by the market assumptions. Where gross incomes are equal, the physicians' work expenditures are equal for time-based and fixed income. Where the physicians' utility is assumed equal, practice inputs for time-based inputs are larger than those for fixed incomes.

Hypotheses Derived from the Model

Use of this model of an individual physician's work and leisure behavior to derive hypotheses which may be tested by comparisons among physicians requires an additional consideration. As long as we have accurately characterized remuneration methods (they simply reflect different financial incentives affecting physicians), we can appropriately aggregate. Most of our results were not dependent upon the model's parameters. To the extent that a physician's remuneration method is a proxy for some other factor which we cannot identify, aggregation may generate unanticipated empirical results.

Overall, we have several sets of hypotheses. Some would have been expected without any sophisticated model. Others, including a dynamic deterministic equilibrium, are less obvious. As could be expected, physicians paid on the basis of their delivery of medical care produce the most output at the least cost. Physicians who are paid on their time at work spend the greater (or greatest assuming decreasing returns in V) amount of time at work relative to practice inputs, to the point of being inefficient. Physicians paid a fixed income are happiest per dollar of income and enjoy the greatest amount of leisure.

Less obvious hypotheses reported in Table 2 include the output-based remuneration as the utility and income maximizing alternative under the equal cost market assumption and the time-based renumeration as the net income maximizing remuneration under all market assumptions.

[5]Decreasing returns to scale in the work production function would cause the time at work to be greatest for wage income, less for output-based income, and least for fixed income. Decreasing returns do not change the independence of the time allocations from any influence of income.

[6]This alternative may also be seen as a market in which a third-party payer makes equal payments to each doctor. From this perspective, the endogenous variables tell how to change the reimbursement rates to maintain payments at a specified level, and what the resulting impacts on output, prices, and productivities would be.

TABLE 2

Ranking of Endogenous Variables for Equal Physician Utility, Equal Physician Gross Income, and Equal Unit Cost of Medical Care

Endogenous Variable		Market Assumption	Ranking			
			Largest	Intermediate	Smallest	
U	physician utility	equal utility	[	Equal by Assumption		]
		equal income	fixed	output-based	time-based	
		equal cost	output-based	time-based	fixed	
Y	gross income earned	equal utility	output-based	time-based	fixed	
		equal income	[	Equal by Assumption		]
		equal cost	output-based	time-based	fixed	
Y/V	unit costs of medical care	equal utility	fixed	time-based	output-based	
		equal income	fixed	time-based	output-based	
		equal cost	[	Equal by Assumption		]
t_z	leisure time	all types	fixed	[output-based =	time-based]	
t_v	work time	all types	[time-based =	output-based]	fixed	
x_z	net income or leisure expenditures	equal utility	time-based	[fixed >, =, or <	output-based]	
		equal income	[time-based =	fixed]	output-based	
		equal cost	time-based	fixed[1]		
x_v	practice inputs or work expenditures	equal utility	output-based	time-based	fixed	
		equal income	output-based	[time-based =	fixed]	
		equal cost	output-based	time-based	fixed	
Z	leisure activities consumed	equal utility	fixed	time-based	output-based	
		equal income	fixed	time-based	output-based	
		equal cost	[all ranks depend upon parameter values]			
V	medical care produced	equal utility	output-based	time-based	fixed	
		equal income	output-based	time-based	fixed	
		equal cost	output-based	time-based	fixed	

[1]Output-based income's rank depends upon the parameters. Solutions available from the authors.

The equal utility and equal cost market assumptions result in the same deterministic dynamic equilibrium, output-based remuneration. If physicians are price takers at unit costs which are equal for all remuneration systems, they maximize their utility by selecting output-based incomes. If physicians are mobile between remuneration methods which are selected by consumers, price-conscious consumers will minimize costs by selecting an output-based remuneration method.

In general, output-based incomes will always be chosen. Output-based incomes are Pareto efficient, while fixed and time-based incomes are not. For any initial time-based or fixed income equilibrium, there exists at least one Pareto superior output-based income equilibrium.

Empirically Testable Hypotheses

The transition from our three "pure" remunerations to the real-world fee-for-service and salary alternatives is not perfectly straightforward. For the purposes of this paper, we presume that the fees of a fee-for-service system are determined by both the physician's time and by the medical care that is produced. Similarly, we assume that salary is some mix of fixed income and time-based income.

Even though the model results we report are at the extreme forms of remuneration, our preliminary examinations with the Cobb-Douglas functions lead us to believe that mixed remunerations cause no unexpected reversals. For example, in a model with all three remuneration types included in one income constraint, time spent at work increases monotonically as the proportion of total income derived from time-based rather than fixed income increases.

Our definitions of fee-for-service and salary remunerations lead us to a number of empirically testable hypotheses.

1. Salaried physicians should represent a very small proportion of the total number of physicians. We find that output-based remunerations are more efficient and are preferred under both the equal utility and the equal cost market assumptions.

2. Compared with fee-for-service physicians, the salaried doctors should earn lower gross incomes. Gross income is greatest for output-based remuneration. Additionally, salaried physicians are less likely to be responsible for paying for practice inputs from their incomes.

3. Compared with fee-for-service physicians, the salaried doctors should work fewer hours. Physicians with output-based remunerations spend more time at work than do those of fixed income for all market systems.

4. Compared with fee-for-service physicians, the salaried doctors should have lower practice expenses. Practice inputs of the output-based income are less than those of the fixed income under all market assumptions. Salaried physicians are less likely to be responsible for paying for practice inputs from their incomes.

5. Compared with fee-for-service physicians, the salaried doctors should produce less medical care. Work output is greatest for output-based remuneration for all three market systems.

Qualifications

The results we have reported are not perfectly general. First, graphical analyses reported by Woodward (1979) indicate that the variable rankings are indeed sensitive to the unitary elasticity of substitution of the Cobb-Douglas function form. For example, a less than unitary elasticity of substitution betwen work and leisure in the utility function reverses the rank of the medical care production of time-based and fixed income. With this smaller elasticity, a physician paid a fixed income will produce more medical care than he or she would for the same time-based income. Alternatively, if all production and utility functions were Leontief, the three systems would produce identical results. This sensitivity to elasticities of substitution argues for some generalization of the functional forms assumed. But solutions for even the next most general function, Constant Elasticity of Substitution, would be extremely difficult arithmetically without much additional generality.

Secondly, our model does not address attempts by any physician employer to directly control input levels. We might well expect employers to intervene with controls to offset the distortions introduced under fixed income and time-based systems. Two such controls are often observed. The first is the requirement of a minimum number of hours at work. Given our assumptions, we would expect to observe minimum-time constraints with fixed-income systems but not with time-based systems, unless team coordination is required.

The second expected employer control applies to the level of production inputs. For example, a salaried physician is likely to find his or her employer providing a number of practice inputs which the fee-for-service doctor would have to buy. In addition, all types of physicians may have access to hospital equipment and personnel at no marginal cost to them.

In our Cobb-Douglas model, practice inputs x_v are the same for fixed and time-based incomes. In the same comparison, work time t_v is greater for time-based income. Since an increase in t_v will raise the marginal physical product of x_v, the incentives for subsidizing x_v will be greater for a time-based system. Thus, while work inputs may be subsidized under both time-based and fixed income systems, we would expect somewhat more subsidization under a time-based system, all else being equal.

A more thorough analysis of the effects of optimum and sub-optimum practice inputs subsidies will be the subject of future work. (Hospital services are complete subsidies for selected practice inputs.) Issues will include the determinants of the size of the subsidy, the characteristics of inputs which should be subsidized, and the effects of monitoring costs.

Empirical Analysis of Physician Income, Practice Inputs, and Patient Visits

The principal objective of this section is to empirically estimate the effects of remuneration method on physician income, practice inputs, and medical care production. These estimates serve both as a test of the hypotheses generated by the models of the previous section and as a measure of the size of the anticipated effects. A second objective of the empirical estimates is to examine the impact of the density of physicians and hospital beds on individual physicians' income, practice inputs, and medical care production. To the extent that physicians are able to generate a demand for their services, physician density will have no effect on individual physician variables.

In the following subsections we 1) introduce the data base, 2) define the dependent and independent variables, 3) consider the hypothesized regression coefficients, 4) report the regression estimations, and 5) summarize the policy implications.

Data Base

Data from the 1976 Physicians' Practice Costs Survey include indications of salary, fee-for-service, expense sharing, income equalizing, and prepaid remuneration types. They also contain measures of a good variety of physicians practice inputs and expenditures, physicians' work times, and physician-patient contacts.

Dependent Variables

The microeconomic model of the previous section developed hypotheses about physician income (y), practice inputs (x_v), leisure expenditures (x_z), time at work (t_v), and medical care production (V). Within the context of the 1976 Survey, physician income is measured by gross income (GRSINC). Although we recognize that gross income for a fee-for-service physician is conceptually different from that of a salaried physician, we nevertheless include a regression equation for GRSINC. The effects of the conceptual difference and of our anticipated differences from the differences between time- and output-based income both lead us to believe that gross income of the fee-for-service physician will be greater.

Leisure expenditures are best measured by net income (NETINC). We estimate equations for three measures of physicians' time at work: patient office hours (OFFHR), hospital round hours (HSPRNDHR), and total medical hours (TOMEDHR).

We examine physician deductions from gross income (MEDDED) as a measure of physician practice expenditures, and we use data on the number of patient office visits (NOOFFVST) and physician hospital visits (NOHSPVST) as alternative measures of the physician's medical care production.

To test the relative magnitudes of the income versus practice input and production effects, we examine the value of each non-income variable per $10,000 of physician's net income (NETINC).[7]

[7]See Appendix 2 for a summary list of the definitions for all variables.

Remuneration Alternatives

The principal focus of this research is on the effects of remuneration alternatives. As we have indicated, fee-for-service and salary remunerations are not straightforward applications of any of the conceptually pure alternatives considered in our model. For the purposes of this paper, we presume that real world fees of a fee-for-service system are determined by both the physician's time and by the medical care that is produced. Similarly, we assume that salary is some mix of fixed income and time-based income.

In the survey instrument, the list of disjoint remuneration alternatives for office-based physicians includes:

1. Salaried employee of a single doctor,
2. Salaried employee of a partnership or group,
3. Solo practice without sharing expenses,
4. Solo practice sharing expenses of one or more of office, equipment, and/or non-physician personnel,
5. Partnership not equalizing income (presumably sharing expenses),
6. Partnership equalizing income (presumably sharing expenses),
7. Unincorporated group not sharing expenses (no information on income sharing),
8. Unincorporated group sharing expenses of one or more of office, equipment, and/or non-physician personnel (no information on income sharing),
9. Incorporated group not equalizing income (presumably sharing expenses),
10. Incorporated group equalizing income (presumably sharing expenses).

For all specialties and remuneration alternatives there is a question on whether the practice is prepaid in whole, in part, or not at all. In practice, this question appears to have been interpreted as payment before services but after risk has been established. Nevertheless, we include the variable PREPAID in the regressions if a physician indicated that the practice was at least partly prepaid.

Necessary Subsample

Because *own* (rather than the group's) gross income is reported for only salaried, solo physicians (who may share expenses) and unincorporated groups (who also may share expenses), the empirical section of this paper focuses on these remuneration types. Additionally, we restricted the number of specialties to the largest six categories in order not to exhaust computer memory in our tests for interaction effects among the independent variables.

These restrictions limit the remuneration alternatives to remuneration type 1 (REMUTYPE 1), who are the salaried employees of single physicians, remuneration type 2 (REMUTYPE 2), who are the salaried employees of a small group (two to nine doctors), remuneration type 3 (the intercept term), who are solo fee-for-service physicians not sharing expenses, remuneration type 4 (REMUTYPE 4), who are solo fee-for-service physicians who share some expenses, remuneration type 7 (REMUTYPE 7), who are unincorporated small groups who don't share expenses, and remuneration type 8 (REMUTYPE 8), who are unincorporated small groups who do share expenses.

These restrictions limit the specialties to general/family practice (in the intercept term), SPECIAL 6, who are general surgeons, SPECIAL 7, who are internists, SPECIAL 11, who are in obstetrics and gynecology, SPECIAL 15, who are pediatricians, and SPECIAL 16, who are psychiatrists.

The net effect of these restrictions is to reduce the sample from 3,482 down to between 800 and 1,000 physicians, depending upon the dependent variable.

Medical Resource Density Measures

A second focus of this research is the significance and magnitude of the effects attributable to the density of each county's principal medical resources: physicians and hospital beds. Observed correlations between health care resources and their utilization are often cited as supporting the hypothesis of supplier-induced demand. The correlation between the density of surgeons and surgery rates is especially notable (Lewis, 1969; Wennberg and Gittelsohn, 1973). Using 1966 State expenditure data, Fuchs and Kramer (1972) find especially high correlations between physician supply and utilization. Similar results are obtained using data from the 1970 National Opinion Research Center study of individual health care utilization and expenditures (Fuchs, 1978; May, 1975) and 1969 gross billings per physician in British Columbia (Evans *et al*, 1973). Despite criticisms of the econometric techniques (Newhouse *et al*, 1979), empirical support for supplier-induced demand continues to be claimed.

We examine the question by including density variables on the right hand side of the income and practice input equations. MDDEN measures the ratio of the number of 1976 physicians to the 1976 population. BEDGHDEN measures the ratio of the number of 1976 general hospital beds to the 1976 population.

Although this research does not attempt to fully address the existence of supplier-induced demand, we must note that there are a number of dynamic market mechanisms other than supplier-induced demand which might account for observed correlations between the number of physicians and the utilization of physician services. These include latent, excess, and/or highly elastic demand for physicians' services and slow market adjustments to changing demands. These mechanisms and supplier-induced demand should leave physicians' incomes and practice inputs unaffected by physician density.

From the perspective of a functioning market, relatively large numbers of hospital beds should increase physicians' productivity, just as additional amounts of capital increase the productivity of any labor input. Clearly, bed density should be significantly correlated with hospital visits and hospital round hours. If the beds increase each physician's overall productivity, then net income should also be proportional to bed density. Because a large number of hospital beds provides a substitute environment for office-based patient contacts, a substitution effect may offset the physicians' increased productivity for patient office visits. The correlations between bed density and patient office visit and between bed density and office hours cannot be signed a *priori*.

Other Independent Variables

Independent variables which adjust for the physician's characteristics include his or her age and sex, possible status as a foreign medical graduate, and the previously described specialty code. We anticipate income to be lower for the younger and older physicians, both because of lower wages and because of shorter work weeks. Conventional wisdom suggests that females and foreign medical graduates may earn less than indicated by their time at work and work outputs.

Other independent variables reflect the demand levels of the area surrounding the physician's practice. These include the county's personal income, percent of the population either younger than five years or older than 64 years, median education, and population density. Our initial maintained hypotheses are that, as measures of demand, personal income, the percent of very young and old, and median education should be positively correlated with physician income, the use of practice inputs, and numbers of physician-patient contacts. Population density is included to control for physician's preferences of more urban areas.

We also include dummy variables for six specialties. Our micro-economic model generates no hypotheses about the effects of specialties on any of the dependent variables. Nevertheless, the 1976 data reported by the AMA lead us to expect surgeons and Ob/Gyn physicians to have significantly higher net incomes. The AMA reports 1976 average net income of $73,245 for surgeons, $65,800 for Ob/Gyns, $60,459 for internists, $47,565 for psychiatrists, $47,438 for general practitioners, and $46,962 for pediatricians.

Variable Averages and Frequencies

Table 3 summarizes some of the key characteristics of each of the continuous and discrete variables. The principal conclusion drawn from Table 3 is that solo fee-for-service is the most frequent remuneration. The number of salaried physicians is 43. The number of solo fee-for-service doctors is 762. This results lends support to our first hypothesis that salaried physicians should represent a small proportion of total physicians.

Averages of the continuous variables in our sample of salaried, solo, and unincorporated group physicians include 1976 average gross and net incomes of $79,400 and $45,800 respectively. These physicians spent an average of 28.7 and 8.9 hours per week seeing office patients and making hospital rounds, respectively. During that time they saw 85 and 37 patients in their office and in the hospital. Overall, they worked an average of 57.4 hours per week. The largest group of physicians were in their 50s. About 18 percent [(190/1036) x 100] were foreign medical graduates. And 8 percent [(82/1036) x 100] were women.

Empirical Estimates

The regressions reported in Table 4 estimate the effects of remuneration types and other relevant variables on the means of physician incomes, practice inputs, and production. The regressions of Table 5 report the effects of the same variables on physician practice inputs and production per $10,000 net income. In every equation, the intercept is

TABLE 3

Descriptive Characteristics of Regression Variables

Part A: Continuous Variables

Variable	n	Mean	Standard Deviation
GRSINC	1036	7.94	4.41
NETINC	985	4.58	2.33
OFFHR	1033	28.68	11.29
HSPRNDHR	1032	8.91	7.86
TOMEDHR	1033	57.41	17.41
MEDDED	809	3.13	2.57
NOPATVST	1025	84.65	69.20
NOHSPVST	785	37.16	37.80
OFHRPNIN	983	7.92	5.42
HSHRPNIN	983	2.20	2.40
TMHRNIN	983	15.39	8.95
MDEDPNIN	798	0.73	0.58
OVSTPNIN	975	21.65	20.12
HVSTPNIN	748	8.20	7.85
BEDGHDEN	1036	0.53	0.27
MDDEN	1036	0.21	0.17
PI	1036	3.60	6.01
POPDEN	1036	0.01	0.01
POPYOP	1034	0.18	0.02
EDUCMED	1036	118.36	9.12

Part B: Discrete Variables

		Value Frequencies											
Variable	n	0	1	2	3	4	5	6	7	8	11	15	16
REMUTYPE	1033		14	29	762	179			10	39			
PREPAID	1036	1013	23										
MDAGEC	1036				201	236	319	204	76				
FMGD	1036	846	190										
FEMALED	1036	954	82										
SPECIAL1	1036						209	154	126		118	154	275

TABLE 4

Regression Solutions

Independent Variables	Dependent Variables							
	GRSINC	NETINC	OFFHR	HSPRNDHR	TOMEDHR	MEDDED	NOOFFVST	NOHSPVST
Intercept	11.93	5.95	41.31	10.06	51.01	5.17	252.32	88.15
	2.32[a]	1.31[a]	5.98[a]	4.10[c]	9.86[a]	1.46[a]	33.14[a]	22.68[a]
REMUTYPE 1	-3.68	-1.36	.59	4.71	13.06	-2.50	-14.92	.53
	1.07[a]	.60[c]	2.77	1.89[c]	4.56[b]	.69[a]	15.17	10.09
REMUTYPE 2	-2.10	-.33	.55	-1.36	-4.37	-2.03	2.22	-5.46
	.75[b]	.42	1.93	1.32	3.18	.49[a]	10.58	6.90
REMUTYPE 4	.07	.18	-.04	-.19	-1.23	-.21	-.92	2.61
	.34	.19	.87	.59	1.43	.21	4.77	3.42
REMUTYPE 7	8.67	2.04	-3.90	2.88	3.15	4.65	17.68	24.68
	1.25[a]	.69[b]	3.21	2.20	5.29	.75[a]	17.61	11.40[c]
REMUTYPE 8	1.97	.64	2.09	1.37	2.64	.61	1.99	11.54
	.65[b]	.37	1.68	1.15	2.76	.43	9.19	6.06
PREPAIDD	-1.59	-.58	-5.18	-1.35	-6.69	-.44	-3.04	3.95
	.83	.47	2.13[c]	1.46	3.52	.50	11.96	8.37
MDAGEC 30's	-.27	-.16	-2.35	-.27	-1.42	-.17	-8.29	2.70
	.37	.21	.95[c]	.65	1.56	.23	5.21	3.72
MDAGEC 40's	.44	.33	-.35	.52	1.27	.32	6.46	-.06
	.34	.19	.88	.60	1.45	.22	4.82	3.37
MDAGEC 60's	-1.42	-.70	-1.16	-.65	-3.42	-.70	-9.87	9.91
	.36[a]	.20[a]	.92	.63	1.51[c]	.23[b]	5.06	3.52[b]
MDAGEC 70's	-3.54	-1.97	-3.19	-3.37	-11.90	-1.93	-25.77	-20.69
	.51[a]	.29[a]	1.32[c]	.90[a]	2.17[a]	.34[a]	7.29[a]	5.60[a]
FMGD	-.14	-.00	-1.61	.98	1.23	-.41	-10.76	-4.44
	.33	.19	.86	.59	1.42	.22	4.74[c]	3.23
FEMALED	-2.22	-1.44	-.53	-1.32	-3.41	-.55	-14.37	-9.78
	.47[a]	.27[a]	1.21	.83	2.00	.34	6.70[c]	4.90[c]
SPECIAL 6	1.12	.94	-13.43	3.93	1.48	-.20	-71.41	19.99
	.42[b]	.24[a]	1.09[a]	.75[a]	1.79	.27	5.98[a]	3.99[a]
SPECIAL 7	.19	.19	-3.57	4.51	.14	-.54	-48.01	5.70
	.45	.26	1.17[b]	.80[a]	1.93	.29	6.46[a]	4.26
SPECIAL 11	1.08	.62	-7.92	-.35	-3.22	.42	-51.06	-8.83
	.46[c]	.27[c]	1.19[a]	.82	1.97	.30	6.56[a]	4.34[c]

(continued)

TABLE 4 (Continued)

Independent Variables	Dependent Variables							
	GRSINC	NETINC	OFFHR	HSPRNDHR	TOMEDHR	MEDDED	NOOFFVST	NOHSPVST
SPECIAL 15	-.32	-.18	3.49	-1.42	-1.86	-.35	4.68	-11.49
	.44	.25	1.14[b]	.78	1.88	.28	6.28	4.23[b]
SPECIAL 16	-1.57	.09	-2.07	-4.01	-9.28	-2.13	-86.84	-16.36
	.41[a]	.23	1.05[c]	.72[a]	1.73[a]	.26[a]	5.77[a]	4.39[a]
BEDDEN	1.55	.72	-.43	3.89	3.16	1.40	11.74	18.83
	.58[b]	.33[c]	1.49	1.02[a]	2.46	.36[a]	8.21	5.68[a]
MDDEN	-2.07	-.99	-5.14	-9.23	-9.77	-1.23	-25.85	-35.38
	1.26	.73	3.25	2.22[a]	5.35	.83	17.86	12.65[b]
PI	.01	.39	-3.52	-4.73	-23.46	1.36	-52.67	-16.34
	.02	1.21	5.52	3.79	9.10[c]	1.34	30.31	22.26
POPDEN	-28.87	-17.77	56.57	-13.87	48.53	-12.84	-306.43	-212.70
	14.49[c]	8.31[c]	37.38	25.62	61.59	9.34	206.45	167.90
POPYOP	2.08	-.23	-19.51	-.87	5.60	-.32	87.47	69.86
	5.72	3.26	14.79	10.14	24.37	3.53	81.48	56.11
EDUCMED	-.03	-.01	-.03	-.00	.09	-.01	-1.09	-.52
	.01	.01	.04	.03	.06	.01	.22[a]	.15[a]
R^2	.23	.16	.23	.25	.12	.27	.39	.22
F	12.89[a]	8.09[a]	13.03[a]	14.55[a]	6.13[a]	12.49[a]	27.13[a]	9.54[a]
Observations	1031	981	1028	1027	1028	805	1020	780

NOTES: Regression coefficients are reported over their standard errors.
[a] indicates significance at the .001 level.
[b] indicates significance at the .01 level.
[c] indicates significance at the .05 level.
All the regression variables are defined in Appendix 2.

TABLE 5

Regression Solutions
(Dependent Variables per $10,000 of Net Income)

Independent Variables	Dependent Variables: OFFHR/INC	HSPHR/INC	TOMEDHR/INC	MEDDED/INC	OFFVST/INC	HSPVST/INC
Intercept	11.29	1.69	12.85	.78	65.20	16.25
	2.95[a]	1.33	5.10[c]	.35[c]	10.40[a]	5.01[b]
REMUTYPE 1	4.05	3.92	12.11	-.33	6.54	5.46
	1.35[b]	.61[a]	2.33[a]	.16[c]	4.70	2.20[c]
REMUTYPE 2	-.17	-.33	-1.64	-.51[a]	1.05	-.92
	.95	.43	1.65	.12[a]	3.33	1.53
REMUTYPE 4	-.41	-.07	-.83	-.06	-1.28	-.14
	.43	.20	.75	.05	1.51	.77
REMUTYPE 7	-2.72	-.44	-2.98	.64	-2.08	-.18
	1.56	.71	2.70	.18[a]	5.45	2.49
REMUTYPE 8	.20	.27	-.15	.11	-.20	1.49
	.84	.38	1.45	.10	2.92	1.34
PREPAIDD	.25	.26	1.18	.06	6.41	2.63
	1.06	.48	1.84	.12	3.79	1.89
MDAGEC 30's	-.53	-.22	-.17	-.03	-2.24	1.11
	.47	.21	.81	.06	1.65	.83
MDAGEC 40's	-.84	-.11	-1.24	.02	-.61	-.93
	.44	.20	.76	.05	1.53	.75
MDAGEC 60's	.59	.03	.85	-.08	.04	-.97
	.46	.21	.79	.05	1.60	.78
MDAGEC 70's	3.29	-.31	3.96	-.18	.37	-2.58
	.66[a]	.30	1.15[a]	.08[c]	2.34	1.25[c]
FMGD	-.74	.44	.16	-.11	-3.08	-.71
	.43	.19[c]	.74	.05[c]	1.51[c]	.72
FEMALED	4.04	.50	6.63	.18	6.90	1.06
	.61[a]	.28	1.06[a]	.08[c]	2.15[b]	1.10
SPECIAL 6	-4.15	.72	-2.06	-.15	-20.88	2.01
	.54[a]	.24[b]	.94[c]	.07[c]	1.89[a]	.88[c]
SPECIAL 7	-.80	1.35	.61	-.18	-11.60	1.43
	.58	.26[a]	1.01	.07[c]	2.04[a]	.95
SPECIAL 11	-2.52	-.08	-1.55	.02	-15.34	-2.21
	-.60[a]	.27	1.04	.07	2.09[a]	.97[c]

(continued)

TABLE 5 (Continued)

Independent Variables	Dependent Variables					
	OFFHR/INC	HSPHR/INC	TOMEDHR/INC	MEDDED/INC	OFFVST/INC	HSPVST/INC
SPECIAL 15	1.26	.16	.15	.05	.71	-2.35
	.57[c]	.26	.98	.07	1.98	.93[c]
SPECIAL 16	-1.02	.97	-3.06	-.50	-22.30	-4.02
	.52[c]	.23[a]	.90[a]	.06[a]	1.82[a]	.97[a]
BEDDEN	-1.45	.72	-2.07	.16	-.19	3.16
	.74	.33[c]	1.28	.09	2.59	1.27[c]
MEDDEN	.42	-2.76	.76	-.09	-1.85	-7.87
	1.65	.75[a]	2.86	.20	5.79	2.93[b]
PI	-3.91	-.92	-10.28	.19	-21.20	-7.12
	2.72	1.23	4.71[c]	.32	9.50[c]	4.90
POPDEN	62.74	12.41	93.74	-.63	16.30	11.94
	18.76[a]	8.48	32.43[b]	2.27	65.90	38.06
POP70YOP	-7.73	-1.24	-2.35	-.39	-.31	7.69
	7.37	3.33	12.73	.85	25.81	12.45
EDUCMED	-.00	.01	.04	.00	-.25	-.07
	.02	.01	.03	.00	.07[a]	.03[c]
R^2	.21	.18	.14	.18	.31	.15
F	11.23[a]	9.21[a]	6.67[a]	7.53[a]	18.18[a]	5.54[a]
Observations	979	979	979	795	971	744

NOTES: Regression coefficients are reported over their standard errors.
[a] indicates significance at the .001 level.
[b] indicates significance at the .01 level.
[c] indicates significance at the .05 level.
All the regression variables are defined in Appendix 2.

the estimated value for 50 to 59 year old male, solo fee-for-service, general (or family) physicians who do not share expenses and who were educated in the United States. In the following paragraphs we discuss the significance of salaried and fee-for-service remunerations, medical resource densities, physicians' sex, age, and foreign medical graduate status.

Remuneration Alternatives

There are a number of significant differences between solo fee-for-service physicians and doctors who are salaried employees of single doctors. The salaried physicians employed by a single doctor earn $36,800 and $13,600 less gross and net income. These results are derived from the coefficients -3.68 and -1.36, row 1, column 1 and 2 of Table 4. REMUTYPE 1 is salaried employees of single physicians. GRSINC and NETINC are gross and net incomes reported in $10,000 intervals.

Salaried physicians spend 4.7 more hours per week on hospital rounds and 13.1 more hours in all aspects of medical care. They do not produce significantly different numbers of patient office or hospital visits. Per $10,000 of net income (Table 5), they work 4.0 more office hours, 3.9 more hospital hours, and 12.1 more total medical hours. They produce 5.5 more hospital visits per week, and their lower medical deductions confirm the expected lower levels of practice expenditures.

These results are not entirely anticipated by our model. Although our expected lower gross incomes and lower practice expenditures are confirmed, salaried physicians of single doctors work longer hours and produce more medical care than the in fee-for-service counterparts. We expected them to work fewer hours and produce less. Interestingly, these unanticipated results are not duplicated by salaried physicians employed by a group of physicians. The group-salaried again earn less gross income and use fewer practice inputs than the fee-for-service doctors but are not significantly different in their hours worked and medical care produced.

One explanation for the unanticipated results and importance of the number of employing physicians is that the remuneration type 1 physicians are young doctors who are on trial as potential partners in already established practices. Although this hypothesis is supported by our discussions with physician friends and relatives, it is not supported by

our (unreported) interaction regressions in which the interaction or dummy variable for young salaried physicians is not significant.

There are no significant differences between fee-for-service solo practices that do and do not share some expenses.

The unincorporated group physicians that do not share expenses earn $86,700 more gross and $20,400 more net income, have greater medical deductions, and make almost 25 more hospital visits per week than the solo fee-for-service doctors used as the basis of comparison.

Supplier-Induced Demand

Although the coefficients of physician density are negative in both the gross and the net income equations, neither coefficient is significant. The implication is that greater physician density does not significantly reduce either physician gross or net income. This evidence leaves us unable to reject the hypothesis that physicians are able to generate their incomes regardless of the number of physicians in the region. Moreover, since we have controlled for the most obvious demand determinants in each area, we can further conclude that this ability to generate income is not obviously demand-related.

As predicted by the hypothesis that hospital beds constitute a factor which increases physician productivity, bed density positively correlates with gross income, net income, hospital round hours, and the number of hospital visits. The positive coefficients in the hospital-hours-per-dollar-of-net-income and the hospital-visits-per-dollar-of-net-income equations suggest lower hospital income per hour and per service unit.

Female Physicians

The female dummy variable generated a surprisingly strong series of coefficients. After controlling for all the variables in the equations, female doctors earn $22,200 less gross income and $14,400 less net income than their male counterparts. This difference appears to be determined by 14 fewer office and 10 fewer hospital visits, but not by fewer office, hospital, or total medical hours. Per dollar of net income, female physicians work longer office and total medical hours and see significantly more office patients (without seeing fewer hospital patients). These results confirm those by Kehrer (1976).

Age

Physicians over 60 earn less income, work fewer hours, and see fewer patients in both the office and hospital. Two significant coefficients indicate that physicians over 70 spend a large number of office and total medical hours per dollar of income.

Foreign Medical Graduates

Foreign medical graduates see fewer patients in the office, spend more time in the hospital per dollar of net income, and see fewer office patients per dollar of net income.

Miscellaneous

Two miscellaneous results run against the hypothesis of a fully equilibrated market. As indicators of demand, personal income, population density, and education should be positively correlated with physicians' income and medical production. But we observe a) that population densities correlate with lower physician gross and net incomes and b) that personal income correlates negatively with total medical hours. The implication is for either 1) a market in which physicians' preferences for more populated, denser, higher income areas affect their practice characteristics or 2) a dynamic market in which high demand characteristics are indicators for low changes in demand.

Finally, we observe that higher median education levels correlate with lower number of both office and hospital visits. This is consistent with hypotheses that educated individuals are healthier and need less medical care.

Qualifications

As in any empirical analysis, we may have generated biased coefficients to the extent that the regression equations omit or incorrectly specify any causal variable. Clearly the regressions do not estimate the behavioral equations of a economic model. Such a series of equations should include price variables and estimate remuneration type as a right-hand dependent variable. Rather, our equations are the reduced form equations which have been suggested by the solutions to the micro-economic model of the previous section. In this context, we have included all those variables which we hypothesize to be relevant, and thus have removed the need for simultaneous equation techniques to estimate the effects of remuneration type.

Summary and Conclusions

This manuscript introduces a model of physician behavior under three alternative remunerations: output-based, time-based, and fixed incomes. We demonstrate the efficiency properties of output-based incomes: physicians will prefer output-based income if employers impose equal unit cost restrictions, and employers will prefer output-based income if physicians move between remuneration systems until their utilities are equal.

By presuming that fee-for-service remuneration is at least partly based on medical care produced and that salary remuneration is in part a fixed remuneration, we derive hypotheses of less income, time at work, and work expenditures for salaried physicians. Our data from the 1976 Survey support our hypothesized predominance of output-based incomes and our anticipated lower earnings and practice expenses of fixed incomes. But we did not expect to find that salaried employees of single physicians work longer hours and make more patient visits per dollar of net income.

Our empirical estimates also lend support for a limited interpretation of supplier-induced demand. Each physician's income, office hours, total medical hours, and office visits are unaffected by the density of physicians. But each physician's hours of hospital rounds and number of hospital visits is negatively associated with physician density. These estimates are consistent with the hypothesis that physicians are able to generate a demand for office, but not hospital, visits.

The data also indicate substantially lower incomes for female physicians, all else being equal. These incomes are explained only in part by female physicians' fewer patient contacts. After adjusting for income, women doctors see more office patients (earn less per patient) and work longer office hours (earn less per hour) than their male counterparts.

Research in the next year of the contract is to proceed in several directions. First, the microeconomic model needs to be given a greater generality than is possible with the Cobb-Douglas functional form. Second, the effects of different physician utility functions are to be developed within the dynamic market context to ascertain if we might expect remunerations to be a proxy for work preferences. Third, we will investigate the importance of free practice inputs to physicians who receive different forms of remunerations.

At this stage in the research, we have found no reason to qualify the conceptual superiority of output-based incomes. Although investigations of the application of the concept to the real physician remunerations is not part of this contract, our conclusions do tend to support experiments with case-rate and diagnostic related group remunerations.

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Appendix I

First Order Conditions

The first order conditions for the fixed income model are:

$$\frac{\partial \pounds}{\partial t_z} = \frac{\gamma\alpha U}{t_z} - \lambda_t = 0 \tag{16}$$

$$\frac{\partial \pounds}{\partial x_z} = \frac{\gamma(1-\alpha) U}{x_z} - \lambda_x = 0 \tag{17}$$

$$\frac{\partial \pounds}{\partial t_v} = \frac{(1-\gamma)\beta U}{t_v} - \lambda_t = 0 \tag{18}$$

$$\frac{\partial \pounds}{\partial x_v} = \frac{(1-\gamma)(1-\beta) U}{x_v} - \lambda_x = 0 \tag{19}$$

$$\frac{\partial \pounds}{\partial \lambda_t} = T - t_z - t_v = 0 \tag{20}$$

$$\frac{\partial \pounds}{\partial \lambda_x} = Y_f - x_z - x_v = 0 \tag{21}$$

The first order conditions for time-based remuneration are

$$\frac{\partial \pounds}{\partial t_z} = \frac{\gamma\alpha U}{t_z} - \lambda_t = 0 \tag{22}$$

$$\frac{\partial \pounds}{\partial x_z} = \frac{\gamma(1-\alpha) U}{x_z} - \lambda_x = 0 \tag{23}$$

$$\frac{\partial \pounds}{\partial t_v} = \frac{(1-\gamma)\beta U}{t_v} + w \,.\, \lambda_x - \lambda_t = 0 \tag{24}$$

$$\frac{\partial \pounds}{\partial x_v} = \frac{(1-\gamma)(1-\beta) U}{x_v} - \lambda_x = 0 \tag{25}$$

$$\frac{\partial \pounds}{\partial \lambda_t} = T - t_z - t_v = 0 \tag{26}$$

$$\frac{\partial \pounds}{\partial \lambda_x} = w \,.\, t_v - x_z - x_v = 0 \tag{27}$$

The first order conditions for output-based income are

$$\frac{\partial \pounds}{\partial t_z} = \frac{\gamma\alpha U}{t_z} - \lambda_t = 0 \tag{28}$$

$$\frac{\partial \pounds}{\partial x_z} = \frac{\gamma(1-\alpha) U}{x_z} - \lambda_x = 0 \tag{29}$$

$$\frac{\partial \pounds}{\partial t_v} = \frac{(1-\gamma)\beta U}{t_v} + \lambda_x \frac{p\beta V}{t_v} - \lambda_t = 0 \tag{30}$$

$$\frac{\partial \pounds}{\partial x_v} = \frac{(1-\gamma)(1-\beta) U}{x_v} + \lambda_x \frac{p(1-\beta) V}{x_v} - \lambda_x = 0 \tag{31}$$

$$\frac{\partial \pounds}{\partial \lambda_t} = T - t_z - t_v = 0 \tag{32}$$

$$\frac{\partial \pounds}{\partial \lambda_x} = p \,.\, V - x_z - x_v = 0 \tag{33}$$

Appendix II

Variable Definitions

GRSINC	Physician's own practice gross income for unincorporated physicians, measured in $10,000
NETINC	Physician's own net income, measured in $10,000
OFFHR	Patient office hours per week
HSPRNDHR	Hospital round hours per week
TOMEDHR	Total medical hours per week (using the second estimate on the questionnaire)
MEDDED	Medical deductions from the physician's own practice, for unincorporated physicians, measured in $1,000
NOOFFVST	Number of patient visits during the week in the physician's office
NOHSPVST	Number of patients visited in the hospital during the week
OFFHR/INC	=OFFHR/NETINC
HSPHR/INC	=HSPRNDHR/NETINC
TOMEDHR/INC	=TOMEDHR/NETINC
MEDDED/INC	=MEDDED/NETINC
OFFVST/INC	=NOOFFVST/NETINC
HSPVST/INC	=NOHSPVST/NETINC
Remuneration Type of the Intercept	Solo physician not sharing expenses
Remuneration Type 1	Salaried physician employed by a single physician
Remuneration Type 2	Salaried physician employed by a group of physicians
Remuneration Type 4	Solo physician sharing expenses with other physicians
Remuneration Type 7	Member of unincorporated group not sharing expenses
Remuneration Type 8	Member of unincorporated group sharing expenses
PREPAIDD	A dummy variable set to 1 if some of the physicians patients are "prepaid"
MDAGEC YY	A dummy variable set to 1 if the doctor's age falls in the age class described by YY
FMGD	A dummy variable set to 1 if the doctor graduated from a medical school outside the United States
FEMALED	A dummy variable set to 1 if the doctor is a female
Specialty Type of the Intercept	General/Family Practice
Specialty Type 6	General Surgery
Specialty Type 7	Internal Medicine
Specialty Type 11	Obstetrics/Gynecology
Specialty Type 15	Pediatrics/Pediatric Surgery
Specialty Type 16	Psychiatry/Child Psychiatry
BEDDEN	The number of short term general hospital beds in 1976 divided by the county's estimated population (in 1,000s) in 1976
MDDEN	The number of physicians in the county in 1976 divided by the county's estimated population (in 1,000s) in 1976
PI	The county's personal income of individuals over 14 years old
POPDEN	The county's population density
POPYOP	The percent of the county's population under four years and over 65 years
EDUCMED	The county's median education level

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Analysis of Physicians' Input Decisions

by Douglas M. Brown and Harvey E. Lapan

This paper addresses the issue of whether physicians underutilize aides (nurses, technicians, etc.). It re-examines and retests the celebrated work of Uwe Reinhardt on production functions with a sample more than four times larger than Reinhardt's. The results show that the physician production function has changed significantly in the last decade. Only in a minority of cases does underutilization of aides exist; on average, physicians use aides efficiently. These findings contrast sharply with those of Reinhardt. Based on estimated production functions, Reinhardt concluded that auxiliary inputs were underutilized. He found that if the optimal quantity of aides had been employed, physicians' output could have increased by about 25 percent.

The researchers argue that the specification of Reinhardt's production function is inconsistent (implying a corner solution) and that the estimates derived are also biased. They show that the direction of the bias will depend on the relationship between the fourth and second moments of the variables. For many distributions, this bias is positive.

Group physicians were found to produce substantially more visits, all else being equal, than solo physicians. A primary policy conclusion from the paper is that, to the extent that visits are a proper measure of output, the formation of group practices ought to be encouraged. With regard to input usage, the paper suggests that no policy changes are required to encourage efficient input use.

Introduction

Since the middle 1960s, the number of physicians has more than doubled in the U.S., yet double-digit inflation in the physicians' services sector is still with us. One of the 'answers' to this inflationary spiral has been to substitute relatively cheaper inputs, that is, aides for physicians, thereby ideally stemming the rate of increase in the cost of producing physicians services. Indeed, the present authors have argued for this policy (Brown and Lapan, 1979). The most celebrated work in the area of substituting cheaper labor inputs for the physicians' time is by Reinhardt (1972, 1975). Using a pooled national cross-section sample of physicians for 1965 and 1967 from *Medical Economics*, Reinhardt found that physicians could profitably employ about twice the number of aides. The increase in output by doubling the aides would be about 25 percent. Since Reinhardt's work was completed nearly a decade ago, the number of nurses has almost doubled nationally;[1] in addition, the production of other skilled medical personnel (physician assistants, extenders, technicians, etc.) has expanded rapidly. Thus, we may no longer expect Reinhardt's findings to be appropriate, although the increase in physicians has been more or less equal to the increase in aides. Thus, all else being equal, the marginal productivity conditions upon which Reinhardt's results were obtained need not have changed.

In this paper we reassess the Reinhardt specification of the production function. We show that Reinhardt's specification is inconsistent, in that interior solutions for aides are not implied. In addition, we find his specification to be biased, and we show that the bias generally results in high marginal products for aides. Using the 1976 Physician Practice Costs Survey, we estimate a specification very similar to Reinhardt's and find that physicians generally are no longer

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[1] In 1964-65 the U.S. graduated 35,000 RNs per year, while in 1975-76 the graduating class exceeded 77,000 per year. In January of 1977, there were over one million RNs employed (854,000 full time equivalents) and over 500,000 licensed practical nurses. The unemployment rate in 1976 was 2.3 percent. These data were taken from *Nurses Training Act, 1975.*

underutilizing aides. In fact, in more than a few cases we find that physicians are overutilizing[2] aides—especially secretary-clerical types. This overutilization prevails especially in groups which share costs equally. Physicians practicing solo or in groups that are not equal cost sharers, that is, practices with incentives to minimize costs, do generally use nursing resources efficiently. Underutilization is found in only a clear minority of cases.

The Reinhardt Model

The production function estimated by Reinhardt is a flexible one, in that aides are not required as essential inputs; that is, output can be produced without them, and their marginal physical product is finite as the number of inputs tends to zero. The production function specified by Reinhardt (1975) is for the i^{th} physician:[3]

$$(1) \quad \log Q_i = a_0 + a_1 \log H_i - bH_i + a_2 \log K_i + \sum_{j=i}^{3} c_j L_{ji} - d\left(\sum_{j=i}^{3} L_{ji}\right)^2$$

where Q = output, H = hours of physician input, K = capital input, and L =registered nurse, medical technicians, and office aides. Reinhardt notes (1975) that it would have been desirable to disaggregate the squared term in (1), but this was not feasible due to multicollinearity problems.

The issue that arises with respect to specification (1) is whether it is consistent, and also what bias is introduced by failing to disaggregate the quadratic term in L_{ji} (aides). Differentiating (1) with respect to L_{ji} yields:

$$(2) \quad \frac{(\partial Q_i/\partial L_{ji})}{Q_i} = c_j - 2d \sum_{j=i}^{3} (L_{ji}).$$

Note that (2) implies that the marginal physical product of L_j (divided by output) is independent of L_j, but depends only on total aides used. The profit (and utility -) maximizing condition for aides is:

$$(3) \quad \left(P_i \frac{\partial Q_i}{\partial L_{ji}} - W_{ji}\right) \leq 0,$$

with $L_{ji} = 0$ if (3) is negative. Using (2), (3) becomes:

$$(3') \quad P_i \left[c_j - 2d \sum_{j=i}^{3} (L_{ji})\right] - W_{ji}\, Q_i \leq 0.$$

But (3′) implies that, except by chance, only one type of aide will be used by a particular physician. To see this, call the optimal output of the physician Q_i^*, and the total aides used (ΣL_{ji}) L_i^*. Further, suppose $L_{1i} > 0$. Then:

$$(4) \quad c_i - 2DL_i^* = (W_{1i} \quad Q_i^*/P_i).$$

For input (2):

$$(5) \quad [P_i[c_2 - 2dL_i^*] - W_{2i}\, Q_i^*] = P_i\left[(c_2 - 2dL_i^*)\left(\frac{W_{2i}}{W_{1i}}\right)\left(\frac{(W_{1i}\, Q_i^*}{P_i}\right)\right]$$
$$= P_i c_2 - 2dL_i^* - \left(\frac{W_{2i}}{W_{1i}}\right)(c_1 - 2dL_i^*) \leq 0.$$

Equation (5) must be non-positive, otherwise the level of L_{2i} could not be optimal. However, it is clear that only by chance can (5) be zero. For example, if $W_{2i} = W_{1i}$, then $L_2 > 0$ only if $c_2 = c_1$; for $c_2 < c_1$, $L_2 = 0$ (if $c_2 > c_1$, $L_1 = 0$). Thus Reinhardt's specification (1) is inconsistent with physicians' employing more than one type of aide.

However, the alternative proposed by Reinhardt—disaggregating the squared term—would not imply this corner solution for aides. Rewrite (1) as:

$$(1') \quad \log(Q_i) = a_0 + a_1 \log(H_i) - b_1 H_i + a_2 \log(K_i) + \sum_{j=i}^{3} (c_j L_{ji}) - \sum_{j=i}^{3} [d_j (L_{ji})^2].$$

Differentiating (1′) yields:

$$(6) \quad \frac{(\partial Q_i\, \partial L_{ji})}{Q_i} = c_j - 2d_j L_{ji}.$$

The profit-maximizing condition yields:

$$(7) \quad P_i Q_i [c_j - 2d_j L_{ji}] \leq W_{ji}.$$

In general, if $P_i\, Q_i\, c_j > W_{ji}$, then each input will be used, regardless of the total level of all inputs. Hence, the alternative specification alluded to by Reinhardt seems more consistent with interior solutions. It is the specification we use in our empirical work below.

[2]By overutilizing, we mean the marginal product per dollar spent on aide inputs is less than the same ratio for other (physician time) inputs.

[3]In its most general form, the production function is

$$Q_i = A \cdot \underset{S}{\pi} [X_{s_i}^{a_s} \cdot e^{-\beta_s X_{s_i}}]\; e^{g[X, L, C]}$$

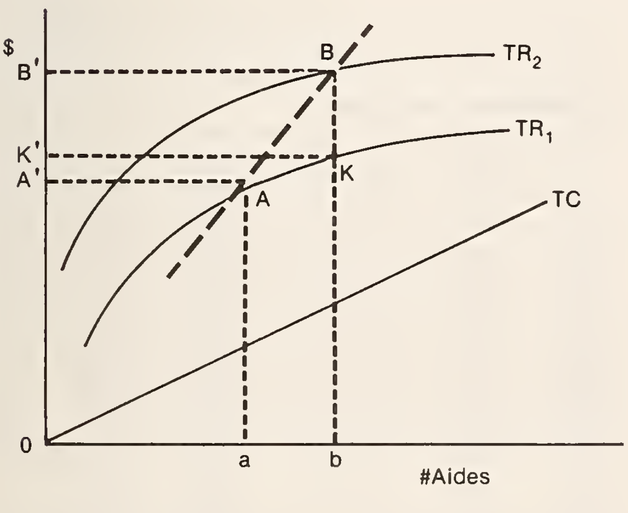
where X_s represents inputs that must be used to get positive output, while L_j are inputs that need not be used for output to be positive.

Bias in the Reinhardt Model

We now want to consider what bias is introduced into the estimates of the marginal physical product by using (1) instead of (1′) while it is clear that bias is introduced by estimating (1) if (1′) is the true specification, the direction of bias in the estimated marginal physical product is unclear. To simplify the analysis, we focus on estimation of the coefficients of L_j, ignoring all other inputs. In Appendix 1, we have shown that the direction of bias depends upon the fourth and second moments of the L_j. Specifically, if the distribution of L_j is smooth and has a finite range (as it must), then Reinhardt has apparently overestimated the marginal product of aides. This of course would possibly lead him to the (erroneous) conclusion that aides are underutilized.

There are two other potential types of bias in Reinhardt's work that are relevant. Newhouse (1978) notes that when firms are observed in a given cross section to infer technology, we will get biased results if the differences in input use are due to ability to use factors productively. Newhouse shows that this bias would lead to overstating the marginal product of aides. If physicians in the cross section face different factor or product prices, then the bias need not exist. If one estimated the production function with a panel data set, this bias problem could be solved. Newhouse's contention is really about the problems associated with cross section data sets. Newhouse illustrates the bias with a diagram similar to Figure 1. TR_1 and TR_2 represent the total revenue of physician 1 and 2 respectively, and points 0a and 0b are the profit-maximizing levels of aide use by 1 and 2. TC is total costs. Reinhardt's model would observe physician 1 at A and physician 2 at B; thus, any physician expanding from 0a to 0b in aide use would presumably raise TR (or visits) by A′B′. In fact, physician 1 would move from A to K, thus overstating the marginal product of aides by BK.

FIGURE 1



Newhouse is referring to cross-sectional data yielding inter-physician differences, that is, we trace out a relationship like AB in Figure 1. If we had a time series of a given cross section, then our estimates could observe the movement from A to K over time for physician 1, and we could learn also about the size of the BK bias.

A second type of bias in the Reinhardt model stems from selection of his sample. If one is going to employ the production function estimates to calculate marginal productivity/factor price ratios and compare to see if the first order conditions hold, then it is imperative that the sample includes physicians that have incentives to minimize costs. Equal cost sharing groups may not have these incentives, yet apparently Reinhardt included physicians of these groups in his sample. It is important to note, however, that a *priori* we would expect equal cost sharing groups to hire too many aides. Thus, given diminishing marginal productivity, this should lead to lower overall estimates of the marginal products of aides.

The 1976 Physician Practice Costs Survey: Input Use

Before discussing the production function estimates and their implications, it is instructive to consider some of the differences in input usage across broad categories of physicians and by specialty. Table 1 gives information on average output and input use per physician, as well as selected physician characteristics. The first row of the table contains data for *all* physicians in our 1976 sample. While 3,482 physicians were surveyed by HCFA, we only used 3,354 in our production function work due to various omitted data problems. Note in row one of Table 1 that average output (Q) measured by total visits per week was 113.5, average hours worked per week by the physician (H) were 59.2, and the total hours used of purchased labor inputs (LT) were 77. The aide hours are broken into five categories: secretarial-clerical (SEC), registered nurses (RN), practical nurses (PN), technicians (Tech) and physician assistants and extenders (PA). Capital is measured as the square feet of office space and average 1,164 in our sample. GRP is the percent of physicians in group practices (37). Fifty-three percent of our physicians are board certified (BCRT). Finally, our total sample averages 22.7 years of experience (EXP) in practice.

TABLE 1

Average 1976 Output, Input, and Practice Characteristics

	Q	H	K	Sec	RN	PN	Tech	PA	GRP	BCRT	Exper	n
All Physicians	113.5	59.2	1164	49.3	10.8	6.6	7.7	2.6	.367	.53	22.7	3354
Solo	100.7	57.5	1167	48.8	9.8	6.2	6.4	2.6	—	.48	23.6	2127
Group	139.6	62.2	1157	50.1	12.6	7.3	10.0	2.7	—	.62	21.2	1227

Sec	secretarial-clerical
RN	registered nurses
PN	licensed practical nurses
Tech	technicians
PA	physician assistants and extenders

Source: 1976 Physicians' Survey

The differences between solo and group (two or more physicians) practices are readily apparent in Table 1. Group doctors produce more visits, work longer hours, and use more aide hours per physician than solos. The average product (total visits per hours worked) is 1.75 for the solo, and 2.24 for the group doctor. Aides are also more productive on average in a group setting. The average product of aides in groups is 1.69, while for solos it is 1.36. While groups use more of all aides compared to solos, groups use a great deal more (in percentages) of RNs and technicians. The amount of square feet of office space used per physician in groups is very similar to that used by solos.

Table 2 contains output, input, and practice characteristics by specialty. The range of the observations for each variable is somewhat large. For example, the lowest Q is 44 and the highest is 172, for a range of 128. Allergists and GPs produce the most visits per hour worked (3.2 and 2.8, respectively), while pediatricians have the most productive aides (2.08 visits/hours worked).

Production Function Specification and Estimation

The first issue in estimating a production function is choosing a functional form. During our research, we worked with the CES, translog, and the transcendental-exponential. The CES was estimated directly using the method of Kmenta (1971). However, the CES is restrictive in that all of the partial elasticities of substitution among input pairs are assumed to be equal and constant. Since we have five aides, capital, and the physician as inputs, this restriction seems too strong. Our work with the translog was based on estimating cost share equations, which is an indirect but far cheaper (dollar wise) approach. The cost share equations are derived on the assumption of cost minimization by the physician firm; thus, if we derived marginal product/price ratios for physicians using the indirectly estimated translog, we would be dealing in an illogical application of the data.

TABLE 2

Average 1976 Output, Input, and Practice Characteristics by Specialty

	Q	H	L	K	GRP	BCRT	EXPER	n
Allergy	118	50.8	113	1406	.24	.35	26.9	146
Cardiology	102	64.3	81	1203	.38	.60	23.9	111
Dermatology	152	47.5	112	1366	.23	.73	22.2	124
Gastroenterology	96	61.3	71	1123	.62	.64	20.8	99
General/Family Practice	172	61.5	97	1073	.28	.14	25.2	362
General Surgery	120	63.6	67	1078	.35	.61	26.2	385
Internal Medicine	128	63.6	83	1078	.35	.39	22.3	296
Neurosurgery	91	63.4	67	1269	.48	.61	19.9	132
Obstetrics/Gynecology	130	62.4	85	1233	.53	.62	21.8	404
Ophthalmology	118	52.0	85	1429	.27	.66	21.2	148
Orthopedic Surgery	128	62.7	102	1355	.59	.77	18.5	133
Otolaryngology	117	53.7	92	1430	.30	.72	21.3	142
Pediatrics/Ped. Surgery	156	60.0	75	1069	.49	.61	23.1	344
Psychiatry/Child Psych.	44	52.2	25	788	.09	.48	20.8	401
Urology	115	60.6	69	1711	.56	.59	20.7	127
Total	113	59.2	77	1164	.37	.53	22.7	3354

Source: 1976 Physicians' Survey

Reinhardt's specification of the transcendental-exponential functional form without the $(\Sigma L_j)^2$ term has been chosen for our work here. This specification has been successfully used by Scheffler and Kushman (1977) and Rossiter (1979). The useful characteristics of this specification are that (1) all aides need not be used by all physicians, and (2) the partial elasticity of substitution among input pairs may be positive (substitutes) or negative (complements), and it need not be constant.

The model we test is:

$$(8)\quad \log Q_i = a_0 + a_1 \log H_i - b_1 H_i + a_2 \log K_i - b_2 K_i + c_1 Sec_i + c_2 RN_i + c_3 PN_i + c_4 Tech_i + c_5 PA_i + d_1 Sec_i^2 + d_2 RN_i^2 + d_3 PN_i^2 + d_4 Tech_i^2 + d_5 PA_i^2 + \alpha_1 PHV_i + \alpha_2 GRP_i + \alpha_3 EXP_i + \alpha_4 BCRT_i + u_i$$

where Q_i = total visits per week of the i^{th} physician; H = total hours worked per week; K = square feet of office space; Sec = weekly hours of secretarial, administrative, and clerical work in I's office; RN = weekly hours of registered nurse work in the office; PN = weekly hours of practical nurse work in the office; Tech = weekly hours of technician work in the office; PA = weekly hours of physician assistant work in the office; PHV = percent of hospital visits (as share of total weekly visits); GRP = 1 if i works in a group of two or more physicians and zero if i is a solo; EXP = years of experience as a practicing physician; BCRT = 1 if the physician is board-certified, zero otherwise. More detail on the definitions of variables used is available in Table 3.

While we are certainly restricted in the type of variables we can choose in estimating the production function, we nevertheless bear in mind that many of our measures are proxies. This is especially true for Q and K. The number of visits may or may not correlate well with output. One can easily imagine that the more successful doctor would have to see his or her patients fewer times for a given illness or during a given time period, other things being equal. K should reflect the flow of office space and equipment services; however, we could not get any good information on equipment services. The reader should note that we have measured the aide inputs in hours, whereas Reinhardt used full-time equivalents. The board certification dummy was used because HCFA wanted to learn about differences between physician practices that were and were not operated by board-certified doctors.

Like Reinhardt, we have estimated (8) using ordinary least squares (OLS). This estimation technique may lead to biased estimates. Rossiter (1979) has estimated this specification for pharmacies using OLS and two stage least squares (2SLS). The 2SLS involved estimating the production function simultaneously with the input demand and (inverse) product demand functions. 2SLS estimation was thought to be appropriate because of expected correlation between the inputs and disturbance term in the production function. Rossiter found that the physician hours coefficient using 2SLS was generally three times that found with OLS, while the aide hours coefficient found with 2SLS was only 1½ times the OLS estimate. Thus, if we want to test the marginal product/factor price ratios for physicians versus aides, we could be biasing our results in favor of aides by using OLS. Rossiter also found that OLS underestimates the marginal product of pharmacy aides at low levels of aide use, and overstates it (relative to 2SLS) at higher levels of aide use. Since groups generally use more aides per physician, if this result carried through for physicians, we would potentially be overstating the marginal product (MP) of aides for groups and understating the MP for solos by using OLS. We hope to employ the 2SLS in future work.

Empirical Results

In Table 4 we present the OLS estimates of equation (8) for all physicians. All coefficients are significant except for the level of K and the intercept term. The coefficient of 1.074 for physicians' time is somewhat larger than that found by Reinhardt; however, when put into elasticity terms, our result is very similar to his. He found an output elasticity ($\hat{e} = a_1 + b_1 H$) of .77 at the mean hours worked for GPs. For our sample, $\hat{e}$ = .74. The coefficient for K is quite low, as other studies that use square footage of floor space only have found. All of the aide coefficients are positive and except for nurses they are significantly different from each other. The negative $\hat{d}$'s imply that the aides are operating under diminishing marginal productivity, although $\hat{d} < 0$ is only a necessary condition[4] for diminishing marginal productivity. At the sample mean for each L_j, we find a positive marginal product that is decreasing for RN, Tech, and PA, and increasing for Sec and PN. The finding of increasing marginal productivity for Sec is not surprising since $\hat{d}_{sec}$ is the smallest $\hat{d}$, and L_{sec} is the largest L. Finally, the b's are useful in computing the rate of change in the marginal products of physicians and capital, respectively. For physicians,

$$\partial^2/\partial H^2 = [((a_1 + b_1)^2/H - a_1 H]\,Q$$

is estimated to be .0014 for our total sample. That is, physicians operate under increasing marginal productivity, even though $b_1 < 0$. At the mean level of K in our sample,

$$\partial^2/\partial K^2 = -.0056.$$

The remaining coefficients in Table 4 refer to the $\hat{\alpha}$'s. Physicians practicing in groups produce 18.3 percent more visits than solo doctors, other things being equal. Reinhardt found that group doctors produced from 4 to 9 percent more visits; however, his GRP dummy required that physicians be in the same specialty. If we make that restriction, $\hat{\alpha}$ increases to .193. The largest group dummy found by Reinhardt was .13 for obstetricians; in our sample, $\hat{\alpha}_2$ for obstetricians is .29.

[4] For any L_j, diminishing marginal productivity requires that $\partial^2 Q/\partial L_j^2 < 0$. Since $\delta Q/\delta L_j^2 = Q[c_j^2 + 4d_j c_j L_j + 2d_j + 4d_j^2 L_j^2]$, it follows that for $d_j < 0$ and L_j large (or d_j small relative to L_j), we can have $\partial^2 Q/\partial L_j^2 > 0$.

TABLE 3

Description of Variables Used in Production Functions

Q	The sum of office, hospital, emergency room, and nursing home visits, plus house calls per week.
H	Reported medical hours per week; includes hours in activities producing Q directly, as well as time spent consulting with other physicians and time devoted to other professional activities.
K	An estimate of square feet of office space. The number was derived by dividing an estimate of the price/sq.ft. of office space into the physicians' reported expenditure on office space. The price data were derived from *Downtown and Suburban Office Building Exchange Report,* 1977, published by the Building Owner's and Manager's Assn. International, Washington, D.C. In this report, data were available on rental income/sq.ft. for downtown and suburban locations for various U.S. cities and regions. Average tenant square footage and prices were available for medical buildings (downtown and suburban) nationwide. By employing a rent-distance curve, one could derive an estimate of price/sq.ft. for each urban area in our sample. For those towns in our sample not in the report, regional averages were used. As a check, our average price/sq.ft. was divided into the reported expenditure on rent in our sample, and the resultant square footage was within 5 percent of downtown and suburban physicians.
Sec	Reported hours/week worked by secretaries, bookkeepers, receptionists, and office managers.
RN	Reported hours/week worked by registered nurses.
PN	Reported hours/week worked by licensed practical nurses.
Tech	Reported hours/week worked by medical, X-ray, or laboratory technicians or aides.
PA	Reported hours/week worked by highly-trained physician extenders, such as physician assistants and nurse practitioners.
EXP	Numbers of years in practice since graduation from medical school.
GRP	A dummy variable equal to 1 if physician practices in a group of 2 or more and equal to 0 otherwise.
BCRT	A dummy variable equal to 1 if the physician has passed a specialty board certified exam, and equal to 0 otherwise.
PHV	Share (%) of Q composed of hospital visits.

Clearly group-based doctors have become more productive in the past decade. Even though 62 percent of group doctors are board-certified, α_4 carries a negative sign in Table 1. Why board-certified physicians produce fewer visits is a question for further research.

Turning to Table 5, where OLS estimates are presented for solo and group doctors respectively, the number of coefficients not significantly different from zero increases. Looking at solos first, the output elasticity for physicians equals 1.0138 since b_1 is not significantly different from zero. All of the $\hat{c}_j$'s and $\hat{d}_j$'s are greater than they are for the total sample. For groups, fewer parameters are significant. If we compute the change in the marginal product for solos and groups respectively, we get a negative value (-.00019) for solos and a positive value (.0016) for groups.

Using the formulas described earlier, it is easy to compute the marginal products for each of the inputs. These are shown in Table 6. Recalling from Table 1 that the average product (AP) or physician time was 1.92 for all doctors, we see that the marginal product (MP) is less than AP_H, that is, that $MP_H < AP_H$. For solos only, $MP_H \cong AP_H$, while for groups, $MP_H > AP_H$. The latter finding implies that physicians in groups are operating in Stage I of production, where MP_H is rising. Consistent with this is the calculation of a positive slope for the MP curve, noted in the previous paragraph. We should also point out that the $AP_{\bar{L}}$ calculated from Table 1 (all = 1.47, solo = 1.36, groups = 1.69), far exceeds the $MP_{\bar{L}}$ in Table 6. When AP $>$ MP for any input, the use of the input is in Stage II, the most profitable area of production if the production function is linearly homogenous.

TABLE 4

OLS Estimates of Production Function for All Physicians

Variable	Parameter	Absolute t value
log H	1.074	8.10
H	-.0056	2.21
log K	.058	3.19
K	$-.104 \times 10^{-4}$	1.29
Sec	.00337	10.94
RN	.00851	10.48
PN	.00842	9.34
Tech	.00523	6.09
PA	.01012	4.47
Sec^2	$-.26 \times 10^{-5}$	6.18
RN^2	$-.40 \times 10^{-4}$	5.08
PN^2	$-.32\ 10^{-4}$	4.27
$Tech^2$	$-.26 \times 10^{-4}$	4.10
PA^2	$-.12 \times 10^{-3}$	3.29
PHV	.165	3.51
GRP	.183	8.57
EXP	.00076	1.28
BCRT	-.0656	3.30
Intercept	-.05	.14
n	3354	
F	107.61	
R^2	.3674	

Efficiency of Input Use

There are two methods one can use to determine whether resources are being used efficiently. First, one can calculate the value of the marginal product (VMP) of the resource and compare it to the wage of the resource. If VMP > wage, then the resource is underutilized, and vice-versa. The second approach is to compare the ratio of MP/resource price across inputs. If the MP/input price ratio for physicians exceeds that for nurses, then physicians are underutilizing their own time.

In Table 7 we have calculated VMPs and input wages for all, solo, and group physicians and their aides. For each of the three categories, the efficiency results are quite similar. Physicians use their own time more or less efficiently. Some inputs (nurses, physician assistants) are underutilized, while others (secretary-clerical) are overutilized. If we consider all aides together, there is very little difference between VMP and average input cost per hour. The VMP calculations are based on the MPs from Table 6 and a net price of \$12.00/visit. The average price of a follow up visit in our sample is \$14.25, but Reinhardt found that the marginal cost of supplies per visit was one-sixth (or \$2.25) in this case. The wage for the physician is net income/hour, while for aides the wage per hour was adjusted upward by 20 percent for fringe benefits.

TABLE 5

OLS Estimates of Production Functions for Solo and Group Physicians

	Solo		Group	
Variable	Parameter	Absolute t value	Parameter	Absolute t value
log H	1.0138	6.45	1.0939	3.85
H	-.0048	1.55	-.0058	1.16
log K	.0626	2.62	.0496	2.11
K	$-.13 \times 10^{-4}$	1.28	$-.12 \times 10^{-4}$	.96
Sec	.00457	11.58	.00092	1.74
RN	.0103	9.68	.00894	5.57
PN	.00917	8.12	.00906	3.93
Tech	.00689	5.98	.00173	1.36
PA	.0121	4.09	.00719	1.85
Sec^2	$-.44 \times 10^{-5}$	7.49	$.14 \times 10^{-5}$	1.34
RN^2	$-.54 \times 10^{-4}$	5.21	$-.74 \times 10^{-4}$	3.34
PN^2	$-.36 \times 10^{-4}$	4.41	$-.72 \times 10^{-4}$	1.72
$Tech^2$	$-.32 \times 10^{-4}$	3.74	$-.56 \times 10^{-5}$	.55
PA^2	$-.15 \times 10^{-3}$	3.29	$-.64 \times 10^{-4}$	.77
PHV	.146	2.32	.142	2.11
EXP	.0013	1.65	-.00031	.37
BCRT	-.0833	3.22	-.0424	1.41
Intercept	.043	.09	.28	.32
n	2127		1227	
F	77.57		22.32	
R^2	.3847		.2389	

TABLE 6

Marginal Products of Physicians, Capital, and Purchased Labor Inputs

	H	K	$\bar{L}$[1]	Sec	RN	PN	Tech	PA
All	1.43	.006	.51	.35	.87	.91	.55	1.08
Solo	1.78	.005	.57	.42	.93	.88	.65	1.14
Group	2.46	.006	.39	.13	1.02	1.12	.24[2]	1.00

[1] $\bar{L}$ denotes the weighted (by hours worked) average of all five aides.
[2] Based on a parameter significant only at the .17 level.

Source: Calculated from Tables 1, 4, and 5

TABLE 7

Value of Marginal Products Versus Input Prices for All, Solo, and Group Physicians

	All		Solo		Group	
	VMP	Input Price/Hr	VMP	Input Price/Hr	VMP	Input Price/Hr
H	$17.32	$18.58	$21.36	$17.38	$29.52	$20.42
Sec	4.20	6.18	5.04	6.11	1.56	6.31
RN	10.44	7.15	11.16	7.34	12.24	6.68
PN	10.92	5.17	10.56	5.06	13.34	5.36
Tech	6.60	6.16	7.80	6.04	2.88	6.40
PA	12.96	7.75	13.68	7.80	12.00	7.67
$\bar{L}$	6.18	6.27	6.85	6.18	4.73	6.33

Source: Calculated from Table 6 and 1976 Physicians' Survey

Marginal product-input price ratios are shown in Table 8. The ratios are exactly the same for all physicians and the weighted average of all aides. As with the VMP data, nurses and physician assistants seem to be underutilized, while secretarial-clerical inputs are overutilized. This finding holds for all physicians and solo physicians. The group ratios reflect the relatively poor estimates of the group production functions; as such, they should be viewed somewhat skeptically.

TABLE 8
Marginal Product Input Price Ratios

	H	$\bar{L}$	Sec	RN	PN	TECH	PA
All	.08	.08	.06	.12	.18	.09	.14
Solo	10	.09	.07	.13	.17	.10	.15
Group	.12	.06	.02	.15	.21	.04	.13

Source: Tables 6 and 7

Summary and Conclusions

In this paper we have re-evaluated the Reinhardt production specification, both theoretically and empirically. Theoretically, we showed that the specification estimated by Reinhardt implied corner solutions, that is, rational physicians would only use one type of aide. In the Appendix we show that the Reinhardt specification would generally lead to MP_L estimates that were biased upward.

Empirically, we found that all inputs to the production process had positive marginal products; however, some were increasing and others decreasing. Group physicians were found to produce substantially more visits, all else equal, than the solo counterparts. In testing for efficiency of input use, we showed that on the average, physicians use aides efficiently. This finding differs from Reinhardt's although we have found that some aides are still underutilized.

The primary policy conclusion from our work here is that group formation ought to be encouraged. This conclusion is restricted by the caveat that visits are a proper measure of output. In regard to input usage, our results imply that no policy changes are required to encourage efficient input use.

Appendix 1

The Direction of Bias in Reinhardt's Production Function

As we showed in the text, Reinhardt's production function specification was (for the ith physician)

$$(1)\quad \log Qi = a_0 + a_1 \log H_i - bH_i + a_2 \log (K_i) + \sum_{j=i}^{3} (c_j L_{ji}) - d \sum_{j=i}^{3} (L_{ji})^2$$

We noted that the last term in (1) implied that (a) the marginal product of Lj depends only on total aides utilized (rather than the level of Lj), and (b) physicians would not be expected to use more than one aide. Since Reinhardt's specification was chosen because it could handle a physician's use of any number of aides, the question arises as to what bias the last term in (1) involves. More specifically, since Reinhardt argued aides were underutilized, we would like to know if (1) leads to an upward or downward bias in estimating the marginal product of aides.

First, we know that by disaggregating the squared term in (1) we do not get corner solutions. That is, more than one aide can be optimally utilized. If we rewrite (1) as

$$(1')\quad \log (Q_i) = a_0 + a_1 \log (H_i) - b_1 H_i + a_2 \log (K_i) + \sum_{i=i}^{3} (c_j L_{ji}) - \sum_{j=i}^{3} [d_j (L_{ji})^2]$$

then the marginal product of an aide is

$$(2)\quad \frac{\partial Q_i / \partial L_{ji}}{Q_i} = c_j - 2 d_j L_{ji}.$$

The profit (or utility) maximizing condition for using aides is

$$(3)\quad P_i Q_i [c_j - 2 d_j L_{ji}] \leq W_{ji}.$$

In general, if $P_i Q_i c_j > W_{ji}$ then each input will be used, regardless of the total level of all inputs. The purpose of our appendix is to determine what bias is introduced in estimating the marginal product of Lj, by using (1) instead of (1'), that is, (1') is assumed to be the true specification.

To simplify the analysis, we focus on the estimation of the Lj coefficients only, ignoring all other inputs. Accordingly, assume the true specification is

$$(4)\quad 1n\,Q = \theta_1 + \theta_2 L_1 + \theta_3 L_2 - \theta_4 [(L_i)]^2 + (L_2)^2].$$

For tractability, we assume there are only two types of aides and that (per 1') $d_1 = d_2$. In vector notation

$$(5)\quad q = X_\theta + \epsilon, \text{ where } (5) \begin{bmatrix} 1n\,q' \\ \vdots \\ 1n\,q' \end{bmatrix} \quad X = \begin{bmatrix} 1 & L_1 & L_2 & (L_1^2 + L_2^2) \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \end{bmatrix};$$

$$\theta = \begin{bmatrix} \theta_1 \\ \vdots \\ \theta_4 \end{bmatrix};$$

thus, q is a column vector of observations of the dependent variable, X is a matrix of observations of the independent variable, θ is the coefficient vector, and Σ is a column vector of error terms. Estimation of θ by least squares yields unbiased estimates ($\hat{\theta}$) if the error terms are orthogonal to the independent variables.

Now suppose that specification (1) is estimated, when in fact (5) represents the truth:

$$(6)\quad q = v \gamma + \epsilon$$

where q and ϵ are as in (5), γ is the coefficient vector to be estimated, and v is a matrix of observations of the independent variables given by

$$(6')\quad v = \begin{bmatrix} 1 & L_1 & L_2 & (L_1 + L_2)^2 \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \end{bmatrix}.$$

Note that (6) corresponds to the model estimated by Reinhardt. Least squares estimation of (6) yields

$$(7)\quad \tilde{\gamma} = (v'v)^{-1} v'q.$$

Assuming the true specification is (5)

$$(8)\quad \tilde{\gamma} = (v'v)^{-1} v' [x\theta + \epsilon] = (v'v)^{-1} v' [(x - v + v)\theta + \epsilon] = \theta + (v'v)^{-1} v'(x-v)\theta + (v'v)^{-1} v'\epsilon.$$

If ϵ is orthogonal to χ, it will be orthogonal to v; hence

$$(9)\quad E\tilde{\gamma} = \theta + (v'v)^{-1} v'(x - v)\theta = \theta + \lambda.$$

Clearly λ represents the expected bias due to using specification (1) rather than (1').

Consider the bias introduced into calculating the marginal products. Evaluating the estimates at the sample means, the true marginal products from (5) are

$$\left(\frac{\partial Q/\partial L_1}{Q}\right) = \theta_2 - 2\,\theta_4 \bar{L}_1 ; \bar{L}_i = \left(\sum_{j=1}^{n} L_j/n\right)$$

(10)

$$\left(\frac{\partial Q/\partial L_2}{Q}\right) = \theta_3 - 2\,\theta_4 \bar{L}_2 .$$

If (6) is estimated, however, the marginal products are (mistakenly) calculated as

$$\left(\frac{\partial \hat{Q}/\partial L_1}{Q}\right) = \gamma_2 - 2\gamma_4(\bar{L}_1 + \bar{L}_2) = (\theta_2 - 2\theta_4\bar{L}_1) + [\lambda_2 - 2\theta_4\bar{L}_2 - 2\lambda_4(\bar{L}_1 + \bar{L}_2)]$$

(11)

$$\left(\frac{\partial \hat{Q}/\partial L_2}{Q}\right) = \gamma_3 - 2\gamma_4(\bar{L}_1 + \bar{L}_2) = (\theta_3 - 2\theta_4\bar{L}_2 + [\lambda_3 - 2\theta_4\bar{L}_1 - 2\theta_4(\bar{L}_1 + \bar{L}_2)]$$

Hence the bias introduced in the marginal product estimates by using the inappropriate specification is

$$E[B_1] = \left(\frac{\partial \hat{Q}/\partial L_1}{Q}\right) - \left(\frac{\partial Q/\partial L_1}{Q}\right)$$

$$= \lambda_2 - 2\theta_4\bar{L}_2 - 2\lambda_4(\bar{L}_1 + \bar{L}_2)$$

(12)

$$E[B_2] = \left(\frac{\partial \hat{Q}/\partial L_2}{Q}\right) - \left(\frac{\partial Q/\partial L_2}{Q}\right)$$

$$= \lambda_3 - 2\theta_4\bar{L}_1 - 2\lambda_4(\bar{L}_1 + \bar{L}_2).$$

If $B > 0$, then specification (1) overestimates the marginal products of aides; the converse is true if $B_1 < 0$. Finally from (9):

(13) $\gamma = (v'v)^{-1} v'(x - v)$, where from (5′) and (6′)

(14) $$(x - v) = \begin{bmatrix} 0 & 0 & 0 & -2L_1^i L_2^i \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \end{bmatrix}.$$

The i superscript in (14) denotes the observation, if there are n observations; (x–v) is an (n x 4) matrix.

Calculating the Bias

The actual calculation of the bias is rather tedious and will only be sketched here. Define

(15) $$l_1^i = (L_1^i - \bar{L}_1);\ l_2^i = (L_2^i - \bar{L}_2);$$

$$y^i = (L_L^i + L_2^i)^2 - \left[\frac{\sum_1 (L_1^i + L_2^i)^2}{N}\right].$$

Further, define the matrix P as

$$P = \begin{bmatrix} \Sigma(l_1^i)^2 & \Sigma(l_1^i l_2^i) & \Sigma(l_1^i y^i) \\ \Sigma(l_1^i l_2^i) & \Sigma(l_2^i)^2 & \Sigma(l_2^i y^i) \\ \Sigma(l_1^i y^i) & \Sigma(l_2^i y^i) & \Sigma(y^i)^2 \end{bmatrix}$$

and its inverse as

$$P^{-1} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

After some extensive calculations, it can be shown that

(16) $$B_1 = 2\theta_4 \Big[2(\bar{L}_1 + \bar{L}_2) \Big\{ [a_{31}\ \Sigma(l_1^i)^2 l_2^i] + a_{32} \left[\Sigma(l_1^i)(l_2^i)^2\right] + a_{33} \left[\Sigma(l_1^i l_2^i y^i)\right] \Big\} - \Big\{ \left[a_{11}\ \Sigma(l_2^i (l_1^i)^2)\right] + \left[a_{21}\ \Sigma(l_1^i (l_2^i)^2)\right] \left[+ a_{31} \left\{\Sigma(l_1^i l_2^i y^i)\right]\right\} - 2\bar{L}_2 \Big].$$

Obviously, a similar expression holds for B_2. To discern the *direction* of bias explicitly, we must make more specific assumptions. Let the distribution of realized values of l_1 be given by $g(l_1)$. Further, assume that l_2 is given by

(17) $$\frac{\alpha l_1 + (1-\alpha)Z}{[\alpha^2 + (1-\alpha)^2]^{1/2}} \quad ; \quad \alpha \epsilon [0, 1],$$

where Z has an identical, but independent, distribution as l_1. Note that α determines the degree of correlation between l_2 and l_1.

Finally, assume that l_1 is symmetrically distributed. That is, all of the odd moments of l_1 vanish ($\Sigma l_1^3 = 0$). Assuming for simplicity that $(\Sigma L_1^i / N) = \bar{L}_1$,

(18) $$B_1 = 4\theta_4 L_1 \left[\frac{(1-c^2)}{(1+c)^2} \quad \frac{(3-\phi)}{((1+c^2)\phi + (1-3c^2))}\right],$$

where $c = \dfrac{\alpha}{[\alpha^2 + (1-\alpha)^2]^{1/2}}$; c is the correlation coefficient between l_1 and l_2, and

$$\phi = \left[\Sigma(l_1^4)/(\Sigma l_1^2)^2\right].$$

Thus the direction of bias depends upon the relationship between the fourth and second moments of l_1. Also note that the greater the correlation between l_1 and l_2 (in absolute value), the smaller is the bias.

Consider the sign of B_1 for various distributions. If l_1 is normally distributed, $E(l_1^4) = (E\, l_1^2)^2$; hence $B_1 = 0$. Thus, for normally distributed values of L_1 and L_2, estimation of (1) gives unbiased estimates of marginal products. However, an economic variable cannot be normally distributed ($L_i \geq 0$).

Suppose l_1 is uniformly distributed between (-g, + g); then

$$E(l_1^2) + (g^2/3);\ E(l_1^4) = (g^4/5);\ \phi = \frac{E(l_1^4)}{(E(l_1^2))^2} = (9/5) < 3.$$

Hence if the observations are uniformly distributed, Reinhardt's specification provides an overestimate of the true marginal product of purchased inputs.

Finally, presume l_1^2 has a parabolic distribution:

$$g(l_1) = 3/4A^3\ (A^2 - l_1^2),\ l_1 \in (-A, A);$$

$$g(l_1) = 0 \text{ elsewhere.}$$

$$\text{Now } E\{l_1{}^2\} = \frac{A^2}{5};\ E\{l_1{}^4\} = \frac{3A^4}{35};$$

$$\Phi = \frac{E[l^4]}{(E\{l_1^2\})^2} = \frac{15}{7} < 3.$$

Thus, as with the uniform distribution, $\Phi < 3$ and $B_1 > 0$, so the marginal products are overestimated.

Conclusion

It is clear that the production function specification used by Reinbhardt is inconsistent, in that it involves corner solutions and yields biased estimates. While the direction of bias is difficult to ascertain, we have shown that it will tend to depend on the relationship between the second and fourth moments of the variables. For most distributions the bias will be positive. If the distribution of realized values is smooth and has a finite range (as it must), then it is likely that Reinhardt has overestimated the marginal physical product of purchased labor inputs. Since his conclusions concerning the underutilization of aides rests upon his estimates of the marginal physical product of labor inputs, his conclusions are suspect, and further analysis is warranted.

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Comments

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Before I came to the Federal government, I was a university-based research analyst, and I acquired substantial experience with physician surveys. The HCFA survey is an important and greatly needed contribution. Providing research grants and contracts to analyze these data is also an excellent step in furthering our understanding of physician behavior.

I find it most useful to view the Brown and Lapan paper in conjunction with the Pauly paper and previous research by Reinhardt. All three studies use a similar production function methodology, but there are dramatic differences in results. The reasons for such differences are unknown, but they could be discovered in further research.

To some extent, I am concerned about the interpretation of the data used in the Brown-Lapan paper. In Table 1, solo practice physicians were much less productive than were group physicians (101 visits per week instead of 140). Group practices tend to use more input physician and aide input. This comparison is consistent with other sources of data, but the magnitude of the difference in patient visits is somewhat larger than I expected.[1] It should be pointed out that the definition of group practice used in this study (two or more physicians) encompasses a wide range of organizational forms. I would expect small single specialty groups to be as different from large multi-specialty groups as they are from solo practices. Some differences in staffing might result from factors not included in this analysis. For example, differences in the volume of insurance forms processed for private insurance, Medicare, and Medicaid might play a role.

A critical problem in the study of physician practices is the allocation of aides to physicians. Individual physicians may report a different number of aides than the group does as a whole due to the sharing of aides. If one examines physicians in isolation, differences in allocation methods may give a misleading picture.

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[1]See, for example, *Profile of Medical Practice*, 1979, American Medical Association, p. 218.

In terms of the regression analysis, the all-physician regression without adjustment for specialty differences should be avoided. When one omits critical variables reflecting inter-specialty output characteristics, the effect of the missing variables is loaded into other variables. For example, board certification is statistically significant in the all-physician regressions but might not be significant if only the data on a single specialty were included in a regression.

I am puzzled by the difference between Pauly and Brown-Lapan. For example, Pauly found group size to be insignificant, yet Brown-Lapan found a significant positive effect on productivity using the same data and methodology.

From a policy standpoint, I am confused about the different production function estimates. Whether aides are over-or under-utilized depends on which set of estimates one accepts. To resolve this issue, the differing results need to be examined and reconciled.

I have two comments on the Woodward paper. First, I do not believe that such a small subsample of salaried physicians is representative of the nation's physicians, especially when you exclude some of the incorporated physicians from the analysis.

Secondly, the supplier-induced demand issue is very important, but including the physician population ratio in the regression equation is not a valid test of a much more complex issue. Because of the potential consequences of an increased future supply of physicians, the supplier-induced demand issue is one which needs to be much more carefully studied. In the Bureau of Health Professions we have a couple of studies that are taking a closer look at this issue.[2] We hope that this research will yield some interesting results.

Finally, we talked about productivity in the sense of producing visits, but an even more important concept of productivity underlies the Department's emphasis on primary care. By having increased and earlier access to medical care, there will be less procedure-oriented care and less use of hospital resources. Even though longer and more thorough patient visits might appear less productive in conventional terms, the system as a whole may well experience lower costs and improved patient health and well-being. Looking at productivity in a more total sense is an important activity which should continue beyond the papers that were presented in this particular session.

[2]See: "The Target Income Hypothesis and Related Issues in Health Manpower Policy," DHEW Publication No. (HRA) 80-27.

Comments

by Edward F. Meeker, Ph.D., American Medical Association[1]

The Woodward-Warren-Boulton paper has two distinct parts. The first part is a theoretical analysis of the impact of alternative reimbursement arrangements on the production of medical services. The second is an empirical analysis of the economic characteristics of medical practice and includes an attempt to test the supplier-induced demand hypothesis.

The authors employ a Becker-type model to explain physician behavior. They assume a Cobb-Douglas form for the physician's utility function. Further, the arguments of the utility function are assumed to be generated by Cobb-Douglas "production functions," one for leisure and one for medical services. They examine three alternative remuneration methods: fixed income, fixed wage or fixed fee.

In order to compare the remuneration arrangements for physicians (fixed income, wage, or fee), additional relationships must be specified. The authors assume that the market works such that among the three reimbursement regimes either: 1) physician utility is equated, 2) physician income is equated, or 3) there are equal costs of producing medical care. The first assumption is the most attractive because it implies that the marginal physician has, to an extent, no preference among a fee-for-service practice, a wage practice, or a fixed-income practice. These modeling efforts generate implications about physician incomes, hours worked, and number of patient visits that are tested in the empirical section.

There may be a problem with the sample selection procedure employed. As noted by the authors, there are few salaried physicians in their data set. However, the percentage of salaried physicians is low, in part, because they eliminated all of the physicians working in incorporated practices. Presumably, those practices are more likely to employ salaried physicians. The authors justify limiting the data set because the survey provides sensible gross income data only for unincorporated practices. It is not clear why they employ gross income in the first place, especially when the relevant comparison is between fee-for-service and salaried physicians. Since salaried physicians do not have to pay office expenses, net income is the relevant comparison.

The specification of the demand relationships in the model may be questioned. Several important demand variables are omitted. The authors do not mention price levels, wage rates, or the extent of insurance coverage.

The discussion of supplier-induced demand is probably the most controversial part of the paper. The standard analysis of supplier-induced demand focuses on fees. Proponents of the theory argue that the physician is somehow able to shift the demand curve for services upward to the right, thus causing prices to rise. However, fees never show up in the empirical analysis of this paper.

The empirical test of the supplier-induced demand hypothesis focuses on the relationship between physicians' incomes and the local physician-population ratio. Standard economic analysis suggests that physician mobility would tend to equalize real incomes. This tendency would hold whether supplier-induced demand or perfect competition prevailed in the market for physicians' services. Thus, finding an insignificant relationship between physician-population ratios and physicians' income is not a good test of the supplier-induced demand hypothesis.

Douglas Brown and Harvey Lapan attempt to replicate and extend Uwe Reinhardt's previous work on the demand for physicians' aides. Their results are substantially different from those of other analysts. The authors conclude that physicians could not significantly improve the efficiency of their practice operations by hiring more assistants.

Brown and Lapan discuss sources of bias in the estimation of production function parameters from cross-section data, including problems specific to the Reinhardt work. They argue that the particular estimating equation employed by Reinhardt biased the estimates of the production function parameters. However, Brown and Lapan's argument would be stronger if they had replicated Reinhardt's work and compared the "biased" estimates with their own "unbiased" ones.

The authors report parameter estimates that are very different from Reinhardt's, in part because of a sample selection rule that limited the data set to "incentive-based practices." These incentive-based practices are defined as all solo practices and those group practices that have non-equal profit sharing agreements. Ruling out group practices with equal profit-sharing arrangements may introduce bias. If there were no systematic sorting of physicians into equal-sharing arrangements or more complicated arrangements, the sample selection procedures followed in this paper would not be troublesome. Unfortunately, this may not be the case. Smaller groups are more likely to have equal-sharing arrangements than larger groups, in part because the smaller groups may have other, more informal ways to monitor behavior. Therefore, the sample selection rule followed in this study cannot necessarily be said to focus on "incentive-based" practices, and the parameter estimates from the sub-population may introduce a new specification error.

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[1]These remarks are published posthumously. They were prepared by members of Dr. Meeker's department from his notes.

Although not without problems, the Brown and Lapan paper is an important study. The authors' emphasis on the issue of specification of production relationships and the sensitivity of results to specification decisions is welcome, particularly for policy formation. For the last 10 years, many policymakers believed that physicians underutilize aides. Brown and Lapan have shown that the research on which that conclusion is based is sensitive to the choice of functional form. Further, the finding that physicians do not underutilize aides is consistent with the view that the market for physician services responds appropriately to economic incentives. There may be some question about the robustness of this finding, but it is consistent with a growing literature that concludes that the health care sector is not fundamentally different from other sectors of the economy.

Physicians' Styles of Practice

by Anthony E. Boardman, Bryan E. Dowd,
John M. Eisenberg, and Sankey V. Williams

The authors have initiated a new line of inquiry into how physicians make decisions about their practices. They have developed a model involving physician preferences over bundles of medical practice attributes such as hours worked, fees, incomes, aides hired, types of patients, etc. They describe physician practices in terms of variables representing inputs to the production of services, output prices, and outputs themselves. Then they use factor analysis to identify clusters of these attributes that might characterize a style of practice, and they estimate a causal model which predicts the style of practice from a set of predetermined variables.

Five styles are identified: (1) many aides, high net income, many patients, and long hours; (2) a high proportion of Medicaid and other low income patients; (3) high fees, high income patients, and high net incomes; (4) many patients with Medicare and other insurance; and (5) many non-medical hours and many hours in non-patient-oriented professional activities. Consistent results on these styles were obtained using data from both the 1975 and 1976 Physicians' Practice Costs Surveys.

Introduction

Over the past 20 years, the price of all goods and services has risen dramatically. However, the annual rate of increase of the Consumer Price Index (CPI) for health care services has consistently risen faster than the overall annual rate, and the health care sector's proportion of the Gross National Product (GNP) continues to rise. In response to concerns about the increasing costs of health care, policy analysts have turned their attention to the economic impact of decisions made by physicians regarding the organization of their practices and the treatment of their patients.

In our present health care delivery system, physicians are the gatekeepers of virtually every type of health care-related resource. This gatekeeper role is evidenced by physicians' economic success and by society's profound trust in their capabilities and integrity. Societal trust in the physicians' decisions results in a special relationship between physicians and their patients. Furthermore, it allows physicians discretionary latitude in determining the form of their production function (including what type of treatment is prescribéd) and, to some extent, cost of output.

In past years, when resources for health care services were relatively more abundant and care was less costly, the physician's agency role simply implied procurement of the best available care. Little incentive existed for economic efficiency in providing health care. Now, mounting costs necessitate an intensified effort to gain insight into the practice decisions of physicians.

Problems Associated With Modelling Physicians' Decisions

Much research about physicians' decisions regarding the organization of their practices and treatment of their patients consists of specifying and estimating traditional microeconomic models of consumption, production, and supply. However, efforts to model the physicians' decisions as economic choices have not been notably successful. (See, for example, Frenzel's comments on Evans' (1976) attempts to unravel the inner workings of the "black box" of the physician's practice.)

The driving force behind rational economic behavior is, of course, decision-making, which reflects the efficient use of scarce resources. Individuals as consumers are assumed to make decisions based on their preferences, the resources at their disposal, and the constraints they face. One problem common to the specification of all behavioral models is correctly distinguishing between variables the individual treats as fixed and those which can be controlled. For example,

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one must decide whether physicians are price setters or price takers.[1] In econometric terminology, one must correctly specify the endogenous (dependent) variables and the exogenous (independent) variables. As the proportion of endogenous variables increases, identification of equations, and therefore estimation of the model's parameters, becomes more difficult. However, representing endogenous variables as exogenous will at least lead to inconsistent parameter estimates in ordinary least squares (OLS) regressions. At worst, it will result in incorrect causal inference, thus leading to misspecified policy alternatives. Consequently, variables must be designated correctly as endogenous or exogenous. In models of physician decision-making, problems arise. The gatekeeper role of physicians means that they exert considerable control over many aspects of their environment: income, leisure, productivity, and other aspects of the practice. A change in one attribute may lead to a change in some of the others. Many variables are endogenous.

Inquiry into individual decision-making often involves the analysis of cross-sectional, non-experimental data, and such data represent a formidable challenge to the assumptions underlying models derived from the traditional microeconomic paradigm. Specifically, to impart behavioral interpretations to relationships among variables in cross-sectional data (such as a change in hours of labor supplied induced by a change in wages or a change in consumption induced by a change in prices or income), one must be prepared to argue that individuals in the sample with similar resources make similar decisions when facing similar constraints. That is, their preferences and therefore their utility functions are similar. As Hausman and Wise (1978) state "(a) common procedure used in both economic and econometric theory is to assume the existence of a 'representative' or 'average' individual who is assumed to have tastes equal to the average (of) all decision makers with given observed attributes." The concept of a representative individual with certain observed attributes may be difficult to support if neither axiomatic theory nor previous empirical evidence suggests groups of individuals with relatively homogeneous preferences. Thus, failure to recognize heterogeneous preferences in the population under study can introduce errors in specification and estimation of economic models.

A major purpose of this research is to reduce the errors inherent in previous economic models of physician behavior by identifying homogeneous groups of physicians for common analysis. At the same time, we recognize that variables which characterize a group are highly interdependent.

[1]See the recent literature review by Juba (1979).

Modeling Physician Decisions

A large number of variables are available to characterize the physician and the practice. We divide these variables into three groups:

i) Practice attribute variables. In our empirical analyses we include in this group the following variables:

a) number of hours worked by aides per physician in the practice,

b) physician's net income from the practice,

c) physician's level of fees,

d) mix of patients seen by the physician, for example, the patients' demographics and types of insurance coverage,

e) number of patients seen by the physician per unit of time by the physician,

f) division of the physician's time across various activities.

ii) Early career choice variables. These include type of specialty, whether the physician is board-certified, size of practice (the number of physicians in the practice) and geographic location.

iii) Exogenous variables. These include the physician's race, sex, years of experience, and income from sources outside the practice.

Thus, variables are grouped according to the ease with which a physician can vary them. Variables in the first group are relatively easy to change at any time. The second group of variables is relatively hard to change soon after the physician has graduated from medical school, and the third group of variables is fixed at any point in time.

Our primary concern is the first group of variables. The following discussion suggests three major simultaneous influences on the practice attribute variables: demand influences by patients, supply influences on the part of physicians, and technological constraints among the attributes themselves.

Consider first the supply influences and physicians' preferences. When discussing preferences for a bundle of commodities such as practice attribute variables, it is useful to refer to a utility function that yields a value of "satisfaction" the individual derives from each bundle. Suppose that a physician's utility depends on income, y, and characteristics of the work environment, Q. While in practice Q will be multidimensional, let us consider only the leisure dimension. All

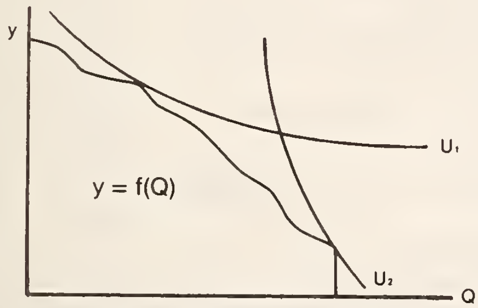
physicians maximize their utility subject to a negative relationship between y and Q, which is analagous to a budget constraint in this example. In other models, the constraints may be analagous to production possibility frontiers. The model becomes

$$(1) \quad \max U(y, Q)$$

$$(2) \quad \text{s.t. } y = f(Q)$$

where $\partial y/\partial Q < 0$. Now suppose there are two types of "representative" physicians whose utility functions, U_1 and U_2, are drawn in Figure 1. In this case we would observe two types of physicians: (a) income preferring physicians who have high income and few leisure hours and (b) leisure preferring physicians who have low incomes but many leisure hours.

FIGURE 1



This simple example considers only two dimensions of the practice. In addition to income and leisure, legitimate arguments of the utility function include productivity, aides, and patients' characteristics. Clearly, it is appropriate to allow for many types of physicians.

Of course, a physician does not have unrestricted control over all practice attributes. For example, a physician cannot work few hours, see few patients, have low fees, and have a high net income from the medical practice. There are limits to the number of patients a physician can see per hour, the number of hours of work per day, and the number of aides which can be supervised effectively. These technological constraints apply to all physicians. They limit the number of types of behavior.

Whatever the particular set of attributes of a physician's practice may be, consumers of physicians' services have preferences over this set. If patients find a particular type of practice unsatisfactory they will, no doubt, seek an alternative type. Clearly, different patients have different needs and different utility functions. For example, elderly patients with chronic illness may have quite different preferences from poor patients with recurrent, acute illnesses. These different preferences generate different demands for certain attributes of the physician's practice.

Just as a physician has a preference for a certain type of practice and type of patients, patients also have preferences for certain types of practices. There is a "matching' between the needs and preferences of physicians and patients. The net effect of this matching process—individual physician with individual patient—is to create a number of what we refer to as equilibrium "styles" of practice. Since there are many practice attributes, and since physicians' and patients' preferences differ, we will identify more than one type of style. Technological constraints, however, limit the number of styles.

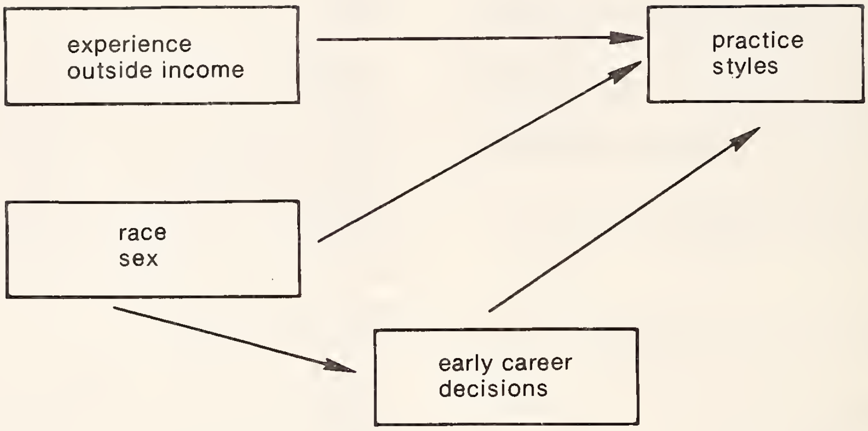
The styles are determined as a result of aggregate physician and patient behavior. We propose first to identify the styles and second, treating the parameters of the styles as relatively fixed, to examine the adoption of a particular style by a particular physician. For this latter purpose we postulate and estimate a causal model which is represented in Figure 2. Basically, we suggest a two-stage process. Physicians first make early career decisions which primarily concern their type of specialty and geographic location. Subseqently, they adopt styles of practice.

Physicians choose a specialty while in training. Upon completion of training, their immediate concerns are geographic location and size of practice. Following graduation, physicians may attempt to become board-certified. Within this group of early career decisions we also include board certification. While this decision is made after choice of specialty, it is usually made before, and may affect, the current practice attribute variables which compose the styles. These early career decisions are functions of a number of exogenous variables; among the set of potential exogenous variables, we have data on physician's race and sex.

The early career choice decisions and all the exogenous variables subsequently affect the style of practice. These relationships may be generated by simple axiomatic constraints (the patients of pediatricians are young) or more complex constraints which have not achieved axiomatic status (patients of pediatricians tend to be uninsured for the treatment provided). They may also reflect different resources and tastes among physicians with different exogenous characteristics. For example, physicians with large incomes outside the practice may see fewer patients per week than physicians with less outside income. Both types of physicians may have a similar utility function; increased outside income simply expands the feasible set of choices. Despite differences among physicians, we expect physicians who make similar early career decisions and who have similar values of the exogenous variables to adopt similar practice styles.

This model assumes that early career decisions, including choice of specialty, "cause" the practice attribute variables and that there is no feedback from those variables to choice of specialty. However, some physicians may elect a certain specialty because of the associated style of practice. Thus, one might postulate that anticipated practice style "causes" specialty. However, this is an insufficient justification to postulate a causal relationship from actual practice style to specialty.

FIGURE 2
Outline of a Causal Model



The issue of timing of major career decisions by physicians has received little attention in the literature. However, a study by Wilson *et al* (1979) suggests that those physicians not associated with the National Health Service Corps (NHSC) make geographic location plans first and then decide about practice community size, extent of involvement in patient care, and eventual specialty. This temporal difference is most pronounced for non-primary care specialty fields (surgeons, psychiatrists, specialists in emergency medicine, and other specialists), and is less pronounced for other primary care specialty fields (internal medicine, obstetrics, gynecology, pediatrics). For family practice specialists and general practitioners, the decisions tend to occur close together. Their data indicate that upon graduation from medical school, over 70 percent of the physicians have made an initial decision concerning geographic location and choice of specialty. The analsysis by Wilson *et al* suggests that it is appropriate to postulate no causal relationship among geographic location, size of community, and specialty. One might also be inclined to include "professional activities" in this set and, in fact, Boardman *et al* (1979) present results containing no causal relationship among any of the early career or practice attributes. It is unlikely, however, that Wilson's definition of "professional activities" corresponds to the practice attribute variables, and we feel justified in supposing that the latter variables are determined after the early career decisions. Nonetheless, the timing of physicians' major decisions requires further research.

Results

Introduction

This section has two major purposes: to identify the practice styles and to estimate a causal model of the determinants of practice style. The section discusses the attributes of each practice style and formally presents the causal model in which we examine style choice. It also discusses the results of the causal model. For these purposes we use data from the 1975 Physicians' Practice Costs Survey. This national survey yields 460 observations for which there was complete information on all relevant items. A description of each variable, the means, and the standard deviations appear in Table 1.

Identification of Practice Styles

We have data on 12 major practice attributes. This analysis identifies a number of styles which will reduce the rank of the matrix of the observations from 12 to a smaller number. Conceptually, the styles are latent (unobserved) variables, with observed practice attribute variables as manifest indicators. The model can be written:

$$(3) \quad y_s = \Lambda_{y_s} \eta_s + \epsilon_s$$

where $y_s(p_s \times 1)$ is a vector of p_s observed practice attributes (in our case $p_s = 12$), Λ_{y_s} x m_s is a matrix of factor loadings, $n_s(m_s \times 1)$ is a vector of m_s unobserved styles of practice (common factor variates), and $\epsilon_s(p_s \times 1)$ is a vector of specific factor variates (error). y_s and n_s are standardized to have zero mean and n_s has unit variance. In addition, $\theta^1\epsilon_s$, the variance-covariance matrix of ϵ_s, is assumed to be diagonal.

TABLE 1

Description of the Variables, Means, and Standard Deviations

Variable Name	Mean (S.D.)	Description
Practice Attribute Variables (y_S):		
AIDHRMD	69.27 (46.34)	Number of hours worked by non-physician employees in the past week divided by the number of physicians (SIZE)
NETINC	54902. (28761.)	Physician's net income from the practice in 1975
FEEOFF	12.31 (4.37)	Physician's current usual fee for a follow-up visit in the office, adjusted by a cost of living index
HIINC	18.20 (18.56)	Percentage of patients with high family incomes
LOWINC	22.53 (21.22)	Percentage of patients with low family incomes
NOINS	12.87 (16.17)	Percentage of patients with no insurance
MDCARE	23.37 (20.40)	Percentage of patients covered by Medicare
MDCAID	11.56 (14.98)	Percentage of patients covered by Medicaid
NUMBER	163.97 (84.56)	Number of patients seen on hospital rounds, in the office, on housecalls, in emergency rooms, in outpatient clinics, and in nursing homes, and the number of operations and assists in the last seven days
MEDHRS	51.68 (16.68)	Hours spent on hospital rounds, in the office seeing patients, on housecalls, in emergency rooms, in outpatient clinics, in nursing homes and on operations and assists in the last seven days.
NONMHRS	6.42 (6.42)	Total hours during previous seven days spent on: filling out health insurance forms, billing patients, personnel matters, general financial matters, hospital administration, and administration of own practice
PROFHRS	8.32 (6.02)	Hours devoted to other professional activities, including reading, writing, research, teaching, and medical meetings in last seven days

(continued)

TABLE 1 (Continued)

Early Career Choice Variables (y_c):		
FAMGP	0.34 (0.47)	General/family practice specialty
SURGERY	0.15 (0.36)	General surgery specialty
PEDTRCS	0.13 (0.34)	Pediatrics specialty
OBGYN	0.14 (0.35)	Obstetrics/gynecology specialty
INTRNST	0.24 (0.43)	Internal medicine specialty
BCERT	0.45 (0.50)	Primary specialty boards; yes = 1, otherwise, 0
SIZE	1.84 (1.71)	Number of physicians associated with the office at least 20 hours per week
CNTYINC	4629. 648.8	Average *per capita* income in the county (1970)
PHYSSQM	17.84 (77.20)	Physicians per square mile (1975)
AGED	0.09 (0.02)	Percent of population over age 65 (1970)
Exogenous Variables:		
OVER10	0.19 (0.39)	Physician and spouse have outside income in excess of $10,000 = 1, otherwise, 0
WHITE	0.95 (0.22)	Physician's race; white = 1, otherwise, 0
MALE	0.93 (0.25)	Physician's sex; male = 1, female = 0
EXPER	22.70 (11.73)	Experience; 1975 minus the year the physician was licensed

To obtain estimates of Λ_{y_s} one must specify *a priori* the number of factors or types of style to be extracted from the practice attribute variables. Choosing the number of factors is not a simple task. In the absence of definite *a priori* guidelines, there are many criteria one might use for selecting the number of factors. One criterion on which there seems to be general agreement is to include those factors with eigenvalues greater than unity. The eigenvalues represent the amount of variance in all the variables explained by particular factors. Choosing those factors with eigenvalues greater than unity assures the inclusion of all factors which explain as much variance in the attributes as any single variable. The eigenvalues for the practice attributes in the 1975 data are shown in Table 2. The first five factors have eigenvalues which are greater than or equal to one. Table 2 also shows the percent of variance in the practice attribute variables explained by each factor. The first five variables taken together explain 61.1 percent of the total variance.

TABLE 2

Percentage of Variance Explained by Each Factor

Factor	Eigenvalue	Pct of Var	Cum Pct
1	2.04	17.0	17.0
2	1.69	14.1	31.1
3	1.38	11.5	42.6
4	1.19	9.9	52.4
5	1.04	8.7	61.1
6	0.88	7.3	68.5
7	0.85	7.1	75.6
8	0.76	6.3	81.9
9	0.65	5.4	87.3
10	0.57	4.8	92.1
11	0.52	4.3	96.4
12	0.43	3.6	100.0

The loadings, Λ_{y_s}, were estimated in two ways. First, we performed a principal components analysis and then subjected the results to a varimax rotation. The resultant varimax-rotated factor loadings are presented in Table 3. Second, to examine the stability of the findings we also performed a maximum likelihood factor analysis, using LISREL.[2] Table 4 presents the findings. All loadings in Table 3 above 0.4 and the corresponding loadings in Table 4 are underlined.

[2]See Jöreskog (1973).

These tables identify five practice styles:

- *Busy, successful, ambulatory care practice.* This style includes physicians who use many aide hours, see many patients, work long hours seeing patients, and have high net incomes. Further research by Boardman *et al* (1979) suggests that these physicians see most of their patients in the office rather than in hospitals or in other settings.

- *Low-income practice.* This style includes physicians who treat Medicaid and other low income patients.

- *Expensive, prosperous practice.* This style includes physicians who charge high fees, see high-income patients, and have reasonably high net income themselves.

- *Geriatric, hospital practice.* This style includes physicians who treat Medicare patients and patients with insurance. Further research by Boardman *et al* (1979) suggests that these physicians see many patients and work long hours in hospitals rather than in the office or in other settings.

- *Academic or administrative practice.* This style includes physicians who work many non-medical hours (administration) and many hours in other professional tasks, such as teaching and research.

Formulation of a Causal Model

This section formally specifies the causal model that is represented by Figure 2; the notation is identical to Joreskog (1973).

Let $\eta' = (\eta_1, \ldots, \eta_m)$ denote a random vector of m latent, true endogenous variables. These variables represent the types of practice styles and the early career choice variables, including choice of specialty and geographic location. Let $\xi' = (\xi_1, \ldots, \xi_n)$ denote a vector of n latent, true exogenous variables; these variables are our exogenous physician characteristics. These variables are related by an interdependent system of linear structural equations:

$$(4) \quad \beta\eta = \Gamma\xi + \zeta,$$

where $\beta(m \times m)$ and $\Gamma(n \times n)$ are parameter matrices, and we employ the usual normalization of setting the diagonal elements of β equal to unity. $\zeta(m \times 1)$ is a random vector of disturbances (errors in equations) with $E(\zeta) = 0$. Without loss of generality we suppose that $\eta_i (i = 1, \ldots, m)$ and $\xi_j (j = 1, \ldots, n)$ are standardized to have zero mean. Further, we assume that β is nonsingular and ξ is uncorrelated with ζ.

TABLE 3

Varimax Rotated Factor Matrix of Practice Attribute Variables

	Style				
	(i)	(ii)	(iii)	(iv)	(v)
AIDHRMD	.704	-.063	.074	-.044	-.107
NETINC	.605	-.066	.426	.027	-.196
FEEOFF	-.023	.042	.813	.077	.033
HIINC	-.043	-.224	.603	-.047	.058
LOWINC	.049	.832	-.058	-.079	.079
NOINS	-.051	-.064	-.091	-.771	.156
MDCARE	-.064	-083	-.049	.765	.191
MDCAID	.001	.850	-.071	.060	-.025
NUMBER	.784	.112	-.212	-.141	.038
MEDHRS	.710	.085	-.138	.162	.172
NONMHRS	.022	-.014	-.018	.003	.866
PROFHRS	-.065	.109	.395	.035	.465

TABLE 4

Maximum Likelihood Factor Analysis Loading

	Style					
	(i)	(ii)	(iii)	(iv)	(v)	(θ^2_{ϵ})
AIDHRMD	.540	-.046	.025	-.028	-.077	.835
NETINC	.504	-.081	.347	.047	-.147	.770
FEEOFF	-.001	.005	.712	.087	.077	.687
HIINC	.045	-.151	.293	.030	.157	.929
LOWINC	.044	.559	-.099	-.048	.045	.820
NOINS	-.056	.006	-.035	-.480	.008	.876
MDCARE	-051	.014	.034	.519	.077	.848
MDCAID	.039	.570	-.027	.067	-.064	.815
NUMBER	.763	.110	-.196	-.140	.036	.597
MEDHRS	.567	.131	-.103	.118	.070	.794
NONMHRS	-.016	.047	.030	-.006	.404	.914
PROFHRS	-.054	-.036	.111	.044	.316	.941

$X^2 = 16.35$

As mentioned previously, the vector η is unobserved; instead we observe a vector of indicators y(p x 1) such that:

$$(5) \quad y = \Lambda_y \eta + \epsilon,$$

where Λ_y(p x m) is a matrix of loadings and ϵ(p x 1) is a vector of measurement errors. E(ϵ) = 0 and each element of ϵ is distributed independently of each element of η, ξ, and ζ. Without loss of generality, each element of y has zero mean. In our application, the y variables are the observed characteristics of the physician's practice and the early career choice variables. We will assume the latter variables are measured without error.

The vector ξ is unobserved; instead we observe a vector of indicators x(q x 1) such that:

$$(6) \quad x = \Lambda_x \xi + \delta$$

where Λ_x(q x n) is a matrix of loadings and δ(q x 1) is a vector of measurement errors. E(δ) = 0 and each element of δ is distributed independently of each element of η, ξ, ζ, and ϵ. Again, it is assumed that each element of x has zero mean.

Finally, Φ(n x n) and Ψ(m x m) denote the variance-covariance matrices of ξ and ζ, respectively. The elements of Ψ provide a measure of goodness of fit. Since ζ_i denotes the error associated with equation i (i = 1, . . . , m), the goodness of fit of this equation is given by

$$(7) \quad R_i^2 = 1 - \mathrm{var}(\zeta_i)$$

$$R_i^2 = 1 - \Psi_{ii}$$

where Ψ_{ij} is the ith diagonal element of Ψ.[3] θ^2 (p x p) and θ^2 (q x q) are diagonal matrices of error variances of y and x, respectively. These error variances provide a measure of how well the latent variables "explain" the observed values; the smaller the error variances, the better.

The model represented by Figure 2 is a block recursive model. There are two sets (blocks) of endogenous variables: five practice styles and 10 early career choice variables. (See Table 1 for a description of these variables.) Suppose we partition η such that $\eta' = [\eta'_s, \eta'_c]$ where η_s (5 x 1) denotes the vector of latent styles and η_c (10 x 1) denotes the vector of early career choice variables. Similarly, we partition y such that $y' = [y'_s, y'_c]$ where y_s (12 x 1) is a vector of practice attribute variables and y_c (10 x 1) is a vector of early career choice variables. We assume that the early career choice variables are measured without error, $\eta_c = y_c$. Also we assume that the exogenous variables are measured without error, ξ = x. We can partition the exogenous variables such that $x' = [x'_s, x'_c]$ where x_s (2 x 1) denotes the exogenous variables, experience and over $10,000 outside income, that directly affect the styles but do not affect the early career choice variables and x_c (2 x 1) denotes the exogenous variables, race and sex, that directly affect the practice styles and early career choice variables. Finally, $\zeta' = [\zeta'_s, \zeta'_c]$ where ζ_s (5 x 1) represents the errors in the practice style equations and ζ_c (10 x 1) represents the errors in the early career choice equations. Now we can write the model depicted in Figure 2.

$$(8) \quad \begin{bmatrix} I_s - \beta_{sc} \\ 0 \quad I_c \end{bmatrix} \begin{bmatrix} \eta_s \\ \eta_c \end{bmatrix} = \begin{bmatrix} \Gamma_{ss} & \Gamma_{sc} \\ 0 & \Gamma_{cc} \end{bmatrix} \begin{bmatrix} x_s \\ x_c \end{bmatrix} + \begin{bmatrix} \zeta_s \\ \zeta_c \end{bmatrix}$$

$$(9) \quad y_s = \Lambda_{y_s} \eta_s + \epsilon_s$$

where I_s (5 x 5) and I_c (10 x 10) denote identity matrices,[5] β_{sc} (5 x 10) represents the effects of the 10 early career choice variables on each of the five practice studies, Γ_{ss} (5 x 2) represents the effects of experience and over $10,000 outside income on styles and Γ_{sc} (5 x 2) and Γ_{cc} (10 x 2) represent the effects of race and sex on the practice styles and early career choice variables, respectively. Equation (9) is identical to equation (3).

Before we estimate the model, we must determine which elements of the parameter matrices will be fixed and which will be free. We allow all elements of β_{sc}, Γ_{ss}, Γ_{sc}, and Γ_{cc} to be free and we estimate these parameters. The structure of Λ_{y_s} is taken from Table 3. All loadings in Table 3 larger than 0.4 in absolute value are set free in Λ_{y_s} and are estimated. All loadings in Table 3 smaller than 0.4 in absolute value are fixed equal to zero. In most cases, a manifest variable is an indicator of only one style; however, net income is an indicator of both styles i and iii.

This model was estimated in two ways, with the off-diagonal elements of Ψ (variance-covariance matrix of errors across equations) set equal to zero and with them free. We report the results obtained with off-diagonal elements set equal to zero because when these parameters are free, the results do not change substantially; in more complicated models, identification problems emerge. The results are standardized so that the variance of each element of η equals unity. The variances of x and y also equal unity because the input consists of the correlation matrix.

[3]Equation (5) assumes that the variance of y equals unity, which holds true in our model since we input the correlation matrix.

[4]The prime superscript denotes the transpose operator. All vectors without this operator are column vectors.

[5]Practice styles are assumed to be causally unrelated to one another, as are the early career choice variables.

Discussion of Results

The results are reported in Table 5. Consider first Λ_{y_s} which appears in Table 5a. A comparison of this table with Table 3 shows considerable consistency. All loadings have the correct signs, although they are slightly smaller in absolute value than those in Table 3. Nonetheless, the elements of $\theta^2\epsilon_s$ which indicate the amount of unexplained variance of each manifest variable are no higher, in general, in Table 5a than in Table 3. The major point is that the descriptions (attributes) of each style in the causal model are similar to those obtained from the rotated factor loadings in the previous section. We now focus on the determinants of each style.

Table 5b contains the other structural form parameter matrices. β_{sc} measures the effects of early career choices on practice styles. Most relationships are consistent with what is generally known about physicians' practices. First we discuss the specialty coefficients which measure the difference between the intercept for that specialty and the intercept for surgeons which is the omitted category. Pediatricians do not treat Medicare patients (with rare exceptions), a fact confirmed by the large negative coefficient for pediatricians in the equation for geriatric, hospital-based physicians (style iv). Internists, on the other hand, often serve as consultants for complicated cases and often see patients with severe problems (Aiken *et al* , 1979). To the extent that the elderly have more severe problems and require more frequent hospitalization than the young, internists are more involved in the hospital care required by the elderly, and the coefficient for internists with a geriatric, hospital practice (style iv) is large and positive. According to the coefficients, internists are also likely to have expensive, prosperous practices (style iii), perhaps explained by their patients' relatively complex, severe problems which require more time-consuming and intensive care (much of which is covered by Medicare and other insurance programs). This explanation is consistent with our finding of a negative coefficient for family practice physicians and general practitioners on this style. Aiken *et al* (1979) find that these physicians see fewer severe cases and fewer elderly patients. An alternative, but less appealing, explanation for these results, is that affluent patients substitute internists for GP/family practice specialists.

According to Girard *et al* (1979), internists spend 30 percent of their professional time on teaching, research, administration, and other professional activities besides patient care. Although comparable figures are not available for other specialists, this amount of non-patient care activity explains the relatively high coefficient for internists with an administrative practice (style v).

The distribution of the other specialty coefficients is consistent with what is known about these practices. Family practice physicians, general practitioners, and pediatricians see relatively more patients in their offices (style i) than do internists and surgeons who concentrate more of their patient care activity in the hospital. For style ii physicians who treat low income and Medicaid patients, the specialty coefficients differ little, except that internists are slightly less likely than other specialists to adopt this style.

Neither board certification, the number of physicians in the practice, county *per capita* income, the density of physicians, nor the age of the population was strongly related to any practice style. However, there were some interesting findings. Rural areas (few physicians per square mile) are mainly associated with styles i and iv, which in turn were associated primarily with family practice physicians and general practitioners. We also found that physicians in urban areas (many physicians per square mile) are more likely than rural physicians to adopt style v—academic or administrative practices, which is expected. These results are supported by Wilson *et al* (1979), and the coefficients for county *per capita* income are also consistent with their findings. The major reason we included physicians per square mile was due to the work of Satterthwaite (1979) and Pauly and Satterthwaite (1979), who argue that price should be related to the number of selllers, as well as the number of sellers *per capita* (although in our data physicians *per capita* and physicians per square mile are highly correlated). We do, in fact, observe a positive loading of physicians per square mile on style iii—high fee, high net income practices. It is not clear, however, that more physicians per square mile cause the fees of all physicians to rise. An alternative explanation consistent with our findings is that, as physicians per square mile rise, some physicians are more likely to adopt the high fee style; some physicians may switch from one style to style iii.

The gamma coefficients measure the direct effects of the exogenous variables on practice styles. These relationships are also consistent with what is known about physicians' practice characteristics. Physicians with large outside incomes are more likely to have expensive, prosperous practices (style iii) than any other style. There are several possible explanations for this. Prosperous practices generate income which can be invested profitably outside the practice to generate additional income. Physicians who can rely on outside income to supplement their practice income can more easily restrict their practices to fewer patients and may possess more entrepreneurial drive needed to attract affluent patients and to run efficient practices.

Male physicians and less experienced (thus younger) physicians are more likely to have busy, successful, ambulatory care practices (style i). Sloan (1975) finds that female physicians have traditionally devoted less time to their practices than have male physicians, and this probably explains why they are less well represented in this relatively active and time-consuming practice style. Similarly, Sloan finds that older, more experienced physicians restrict their practice activity which leads one to expect they also would be less well represented in this practice style.

TABLE 5a

Lambda y (Λy_s) For Causal Model

	Style					
	(i)	(ii)	(iii)	(iv)	(v)	($\theta^2_{\epsilon_s}$)
AIDHRMD	.573	—	—	—	—	.820
NETINC	.506	—	.487	—	—	.760
FEEOFF	—	—	.619	—	—	.787
HIINC	—	—	.365	—	—	.934
LOWINC	—	.625	—	—	—	.774
NOINS	—	—	—	-.320	—	.951
MDCARE	—	—	—	.854	—	.556
MDCAID	—	.512	—	—	—	.865
NUMBER	.750	—	—	—	—	.661
MEDHRS	.548	—	—	—	—	.837
NONMHRS	—	—	—	—	.392	.921
PROFHRS	—	—	—	—	.413	.916

TABLE 5b

Structural Form Parameters

BETA (β_{SC})

Style	FAMGP	PEDTRCS	OBGYN	INTRNST	BCERT	SIZE	CNTYINC	PHYSSQM	AGED
(i)	.326	.214	-.100	.051	.067	.094	-.233	-.075	-.058
(ii)	.007	-.052	-.062	-.155	-.124	.006	-.084	.072	.008
(iii)	-.324	-.212	.157	.167	.162	.001	.074	.141	-.110
(iv)	.084	-.518	-.337	.425	.054	-.075	.032	-.041	.041
(v)	-.092	-.132	-.188	.060	.004	-.098	.165	.272	.089

GAMMA ($\Gamma_{SS}\Gamma_{SC}$) PSI (Ψ_S)

Style	EXPER	OVER10	WHITE	MALE	
(i)	-.233	-.014	.025	.183	.744
(ii)	-.059	.008	-.378	.116	.792
Iiii)	-.004	.310	.044	.061	.503
(iv)	-.055	.087	.038	-.030	.362
(v)	-.041	-.005	-.092	.050	.769

GAMMA (Γ_{CC})

	MALE	WHITE	Ψ_C
FAMGP	.040	.038	.995
SURGERY	.065	-.047	.992
PEDTRCS	-.102	-.019	.988
OBGYN	-.135	-.003	.981
INTRNST	.089	.010	.990
BCERT	.049	.011	.996
SIZE	.027	.013	.997
PHYSSQM	-.131	-.004	.982

There is a strong relationship between non-white physicians and practices characterized by Medicaid and other low income patients (style ii). Our findings suggest that non-white physicians treat more low income patients (per physician) than do white physicians. If our assumptions are correct and exogenous variables such as race determine the choice of practice style, this means that non-white physicians choose practices with low-income patients more often than do white physicians.

The effect of race and sex on the early career choice variables appears in Γ_{cc}. While the equations have poor fits, the table suggets that male physicians are more likely than female physicians to become family practice/general practice specialists, surgeons, or internists while female physicians are more likely to become pediatricians, obstetricians, or gynecologists. White physicians appear more likely than non-white physicians to become family practice/general practice specialists or internists while non-white physicians are more likely to become surgeons, pediatricians, obstetricians, or gynecologists. White physicians and male physicians are more likely to become board-certified, to work in a large practice, and to work in areas which have few physicians per square mile than are non-white physicians or female physicians.

The model presented above is the structural form model. The parameters reflect the direct effect of each explanatory variable (which might be endogenous) on each endogenous variable. The reduced form parameters measure the total effect of each exogenous variable on each endogenous variable. The effects of the exogenous variables (experience, over $10,000 outside income, race, and sex) on each style are reported in Table 6. A comparison of this table with the gamma matrices in Table 5b shows that the structural form parameters are very similar to the reduced form parameters, and the indirect effects of the exogenous variables are negligible.

The estimated variance of the errors in equations, Ψ, appears in Tables 5b and 6. A comparison of these tables shows that the inclusion of the intermediate choice variables significantly increases the explanatory power of the model, particularly for styles iii and iv whose R^2 increases by 0.36 and 0.60, respectively.

Implications For Public Policy

In reviewing the research and legislative history regarding physician decision-making, one discovers that there is no clear definition of "desirable" physician behavior. Several specific practice decision variables have been studied, but never in the context of a comprehensive statement of objectives regarding physician behavior. Reluctance to define desirable physician behavior may be attributed, in part, to lack of the technical expertise, outside of the medical sector, which is required to accurately assess the quality of medical outcomes and procedures. Another reason may be the realization that, given the number of practice variables under the physician's control, it may be difficult to manipulate one variable through legislation without causing unexpected, undesirable changes in others. Practice attributes are linked by a complex set of relationships. The concept of styles serves to reduce the degree of complexity to a more manageable level by identifying the various forms of physician behavior. Interestingly, some policy discussions involving physician behavior already focus on styles of practice which transcend single variables. The Medicaid "mill" is one example.

Second, the relationship of individual physician characteristics to practice styles may suggest appropriate policies for medical school admissions and State licensing boards. It certainly appears that increasing the number of minority physicians would increase the access of low-income and Medicaid patients to physician services. However, this finding may be due to structural constraints and should therefore be accepted with caution.

Third, the styles are interesting because they measure the sensitivity of physicians to incentive reimbursement and other cost containment strategies. Physicians who maintain expensive, prosperous practices (style iii) are not strongly associated with Medicare or Medicaid patients and thus may be relatively impervious to incentives or penalties involving

TABLE 6

Reduced Form Parameters

Style	EXPER	OVER10	WHITE	MALE	Ψ
(i)	-.247	.005	.025	.229	.888
(ii)	-.023	-.001	-.417	.118	.817
(iii)	-.132	.368	.067	.042	.863
(iv)	-.042	.156	.054	.115	.961
(v)	-.034	.022	-.113	.046	.984

these two types of reimbursement. One would expect physicians practicing in low-income (style ii) and geriatric (style iv) styles to be more sensitive to changes in these reimbursement policies, particularly since they treat a relatively large proportion of Medicaid and Medicare patients, respectively, and do not appear to have high net incomes.

Finally, we may consider the responses of physicians who practice in the various styles to other changes in their decision-making environment. It seems plausible, for example, that physicians practicing in a busy, successful practice (style i) would exhibit a different labor supply response to changes in fees or wages of aides than physicians practicing in an expensive, prosperous style, where fewer patients are seen per day or per week. On the production side, one might find that physicians of one style are able to make more efficient use of clerical or clinical aides than physicians of another style.

Summary

The process by which physicians make decisions concerning the organization of their practices is not well understood, despite intensive research efforts in the last decade. Established theories, such as those stemming from microeconomics, provide models of consumption, production, and supply decisions. However, when tested empirically, these models have limited ability to predict individual physician behavior.

In this paper we have initiated a new line of inquiry into the ways in which physicians make decisions about their practices. We have considered the possibility that significant differences in preferences over bundles of practice attributes exist among groups of physicians. Retaining the economic concept of decisions based on consumer and producer preferences, resources, and technological constraints, we developed an alternative model. We have described the physician's practice using variables which represent inputs to production of services, output prices and outputs themselves. We then examined the decisions that physicians make, looking for evidence of underlying structure or mechanisms which generate the observed data:

We have identified five latent characteristics of practices which we refer to as "styles" of practice. These do not represent discrete choices on the part of the physician. Physicians do not choose style i instead of style ii. Rather, we think of physicians as choosing a style which is, for example, strongly characteristic of style i or style ii or both, and not strongly characteristic of style iii. Styles may be thought of as characteristics of the practice which transcend single attributes. These styles help to explain the variance in the attribute variables and they correspond to intuitively appealing concepts of practice style which have arisen from previous research and empirical observation. Boardman *et al* (1979) found that the styles are robust when subjected to validation using the 1976 Physicians Administrative Practices Survey.

We next investigated the mechanisms which generate the styles of practice. We posited a causal model in which practice styles were functions of previous career decisions by the physicians and exogenous factors such as the physician's age, sex, and experience. These findings were discussed in the previous section.

Several extensions of this research are warranted. First, practice styles may be strongly influenced by combinations of early career choice variables, such as the choice of specialty combined with the choice of geographic location or size of practice. One simple improvement in our causal model would be the addition of interaction terms representing combinations of early career choices. Second, one might argue that, in addition to the effect of specialties on actual practice style, the anticipated style of practice may influence specialty choice. However, panel data are necessary to test this additional hypothesis.

Finally, we intend to use the results from this paper to examine the determination of individual practice attribute variables. We will classify physicians into groups according to which style describes them best. For each group we will then estimate physicians' labor supply equations, production functions, and demand equations for practice input variables.

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Marginal Wage Rates, Hours of Work, and Returns to Physician Training and Specialization

by Stephen P. Dresch

This paper estimates professional earnings functions for 15 professional occupation groups, using the 1977 Current Population Survey Annual Demographic File (CPS). This file contains information on individual hours and earnings for calendar year 1976. In comparison to alternative occupations, physician training is found to be an extemely profitable investment when the nonlinearity of the hours-earnings relationship in professional occupations is recognized. A substantial element of pure economic profit is found in physicians' lifetime earnings.

With the exception of law, the choice of medicine over alternative occupations is equivalent to purchasing an annuity which will pay the 18-year old over $4,000 in every year until age 65; in many cases the annual payment would exceed $10,000. Even at "full cost" medical school tuition, and assuming a continuation of current subsidies to all other forms of schooling, the annuity would pay over $4,000 per year by comparison to all but two alternative occupations. This indicates quite graphically the extreme profitability of a medical career.

> After ten years of work on earnings functions, all we have is a dim light at the end of a tunnel: everyone has been wrong and everyone has been right because the problem has proved to be more complicated than was originally imagined.
>
> Mark Blaug
> (1976, p. 845)

Work Effort and Returns to Occupational Choice

Even before the proliferation of studies of the returns to occupational choice under the rubric of contemporary human capital theory, as grounded in the work of Schultz (1960), Becker (1964), and Mincer (1958), professional practice was recognized as a distinct and possibly unique subject of microeconomic study. As early as 1945, Friedman and Kuznets portrayed the economics of independent professional practice as an intersection of the theory of the firm and of labor economics, with the professional practitioner simultaneously playing the roles of entrepreneur, principle supplier of labor to the firm, and human capital investor. However, because interest has focused primarily on the human capital investment of professional training, the analytical complexity and richness associated with this juxtaposition of roles have not been recognized or exploited in the literature.

With the notable exception of Reinhardt (1975), who was concerned with the composition of inputs into professional (medical) practice, previous studies have been preoccupied with the estimation of returns to professional training and the choice of a professional career. Fundamental to such estimates is the concept of the "earnings function," relating earned income to its determinants. From a very simple formulation from which rates of return to schooling could be directly derived, theoretical development (and empirical application to a lesser extent) has involved the progressive generalization of the earnings function to incorporate such complex factors as post-schooling investment in and obsolescence and depreciation of human capital.

Variations in work effort have provided a relatively recent focus of interest in this context. Adjustments for these variations, however, have been grafted rather simplistically onto the existing earnings function analyses, without concern for such potential complications as systematic variations in income-leisure preferences, the possible nonlinearity of the relationship of earnings to hours of work, and the effects of age and experience on the returns to work effort in alternative occupations.

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These lacunae in the analysis of returns to occupational choice as modified by variations in work effort provide the motivation for the present study. The conceptual importance of accounting for hours of work differentials in assessing returns to human capital investment was first stressed by Lindsay (1971), who demonstrated that, on the assumption that leisure is a normal good, the observed income differential associated with a human capital investment overstates the return to that investment. This is true because the investment increases the wage rate (price of leisure), thus inducing a substitution of work (and hence consumption of purchased goods and services) for leisure. Some fraction of the income differential therefore represents not a return to the human capital investment *per se*, but rather compensation for the additional work effort induced by the increased wage resulting from the investment.

The empirical significance of the adjustment of earnings differentials for variations in hours of work has been demonstrated by Eckaus (1973), examining returns to years of schooling, and Lindsay (1973), focusing on returns to physician training. Sloan (1976) has seriously questioned Lindsay's conclusion that medical training represents, at best, only a marginally profitable investment if appropriate adjustments for work differentials are made, arguing that this result derived from a substantial overestimate of physician hours relative to hours of work in comparison occupations. However, the basic thrust of Lindsay's argument has been generally accepted. For example, Sloan and Feldman (1977) have incorporated an hours-of-work adjustment in applying Rosen's (1977) human capital model to the estimation of the rate of return to medical training.

As Lindsay has observed, the adjustment of earnings for differences in work effort across occupations inevitably confronts what is essentially an index number problem. Assume that the wage rate (per hour) is higher in occupation i (for example, medicine) than in comparison occupation j (for example, college teaching), and the observed hours of work are also higher in i than in j.[1] If the returns to occupational choice i are estimated on the basis of an upward adjustment of earnings in j by the ratio of hours in i to hours in j (a Paasche index), then real returns will be unambiguously overestimated. A Laspeyre index (adjusting earnings in i downward by the ratio of hours in j to hours in i) will generally underestimate returns.

Even apart from this complexity, however, the adjustments proposed by Lindsay and employed by Eckaus, Lindsay, and Sloan and Feldman effectively rest on several highly restrictive but implicit assumptions. Specifically, the proportionate adjustment of earnings requires the assumptions that

1. the number of hours worked is freely variable by the individual, that is, institutional rigidities do not constrain the amount of time devoted to work;

2. relative hours worked in alternative occupations do not vary systematically over the working lifetime;

3. individual preferences for income versus leisure do not differ systematically across occupations; and

4. the wage rate is (a) given and (b) constant, that is earnings are a linear function of hours worked, with equality of the average and marginal wage rates.

If any one of these assumptions is violated, the conventional adjustments for interoccupational hours of work differentials are inappropriate.

With reference to medical practice and to a range of reasonable comparison occupations, the first assumption of freely variable hours of work is probably not unreasonable, although constraints may be encountered in particular employment settings. However, if the employment setting is itself subject to choice, if the option of a setting in which hours are variable is available, and if intraoccupational markets are in equilibrium, then no qualification is required in this dimension.

The second assumption, of life cycle-constancy of relative hours in the alternative occupations, is implicit in the utilization of mean hours, uncontrolled for age or experience, in the available empirical estimates of the hours adjustment factors. Given the inversely exponential weight associated with differential earnings accruing further in the future, an observed mean differential in hours will have a greater effect on returns directly proportionate to the degree to which it is concentrated in the early phase of the working lifetime. This effect, however, will not be reflected in the adjusted estimates available in the literature. Superficially, it might be thought that use of age- or experience-specific hours-of-work adjustments would have only second-order consequences for estimated returns. However, if the life cycle profile of work effort (and as discussed below, of returns to work effort) varies significantly across occupations, the effects may indeed be substantial. Moreover, if age-experience distributions of personnel differ markedly across occupations, then significant differences in observed mean hours would be consistent with identical life cycle profiles of work effort, raising the possibility that the conventional mean-hours adjustments incorporate serious biases.

The third assumption, of the absence of systematic variations across occupations in preferences in the income-work (leisure) space, is also subject to serious question. Specifically, an earnings differential which would just compensate one individual for the cost of a human capital investment which increases his or her wage rate will imply a surplus for

[1] Although the latter is not a necessary consequence of the former, as, for example, if the individual labor supply function is backward-bending (the income effect of the higher wage rate outweighs the substitution effect), it can be demonstrated that the relationship between the wage rate and hours of work is necessarily positive if all labor-cum-human capital markets are in long-run equilibrium (in which case there is no income effect).

an individual whose marginal disutility of work rises less rapidly with an increase in hours. Thus, interpersonal variations in the disutility of work will be reflected systematically in occupational choices. As a result, adjustments of earnings for hours differentials across occupations will result in biased estimates of real earnings differentials. If all labor-cum-human capital markets were in perfectly competitive, long-run equilibrium, then the marginal entrant into any occupation would be at least as well off in that occupation as in any other, and only inframarginal individuals would receive rents, although positive or negative net returns might be indicated by the conventional hours-adjusted earnings differentials. However, if restrictions on entry into alternative occupations exist, then these conventional adjustments might disguise the existence of substantial rents even at the margin, if preferences differ significantly across occupations.[2]

The final assumption of a constant marginal (equal to average) wage is highly suspect, especially in the independent or quasi-independent professions. This assumption rests on a conception of a market in which labor, in time-defined units, is exchanged for earnings at a fixed wage rate, implying that earnings in many occupations are a complex function of own time and other inputs subject to individual control. While this is explicitly the case in independent practice, for example, in medicine or law, even in many ostensible "employee" situations, this characterization of earnings often applies, at least in the intermediate run.[3]

Several sources of a declining marginal wage rate can be suggested. First, individual efficiency may decline with an increase in hours of work, as reflected in a declining marginal product of labor. Second, observed total earnings may incorporate a significant fixed component, or rent, independent of hours of work and output. This would be the case, for example, in a group practice in which the earnings of a senior member include an essentially fixed element based upon the earnings of the group as a whole, or in an institutionally-based practice in which a salary or retainer is supplemented by fees for services provided. On either of these counts, the average wage rate would decline with increases in hours, lending a downward bias to hours-adjusted estimates of inter-occupational earnings differentials.

A third source of average-marginal wage differences emerges when earnings are recognized as a function not only of own time but also of other inputs. If these other inputs are perfectly divisible and freely variable at fixed market prices, then variations in the marginal wage rate will be observed only if the production relating "output" (gross income) to inputs exhibits increasing or decreasing returns to scale or is nonhomogeneous with respect to some or all inputs. If, in addition, markets for other inputs are imperfectly competitive, that is, if the quantities of these inputs can be increased only at increasing prices, or alternatively, if these inputs are subject to indivisibilities, then net income might well rise more or less than proportionately with increases in hours.

Finally, if the market for the individual's output (services) is imperfectly competitive, then the marginal revenue product of hours of work will decline, even if none of the factors discussed above serves to introduce a discrepancy between marginal and average wage rates. Consider, for example, an extreme case in which the production function exhibits constant returns to scale with respect to hours, but the elasticity of demand is (minus) unity; in this case the marginal wage rate would be zero at all levels of hours. In general, the marginal wage will decline more rapidly, the lower the elasticity of demand.

The estimates of returns to physician training and specialization developed here explicitly recognize systematic inter-occupational differences in life cycle patterns of work effort and nonlinearity of the hours-earnings relationship. Later extensions of the analysis will recognize interoccupational differences in work-leisure preferences and inputs other than own time in the determination of earnings, both of which are ignored here.

The Professional Earnings Function and Returns to Professional Choice

In principle, professional hours of work and earnings must be viewed as simultaneously determine to maximize utility subject to production and demand function constraints. A point of departure is provided by the model developed by Reinhardt (1975).

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[2]It is not obvious, a *priori*, that systematic differences in preferences which would be observed in the absence of entry restrictions would also be observed in the face of such restrictions. This would be the case only if selection criteria for rationed entry were correlated with individual income-leisure preferences. However, if the "gatekeepers" act to maximize the aggregate real rents to the occupations members, then they will systematically select entrants on the basis of these preferences. The same effect may be achieved indirectly. Thus, if the probability of obtaining entry is contingent on academic performance, for example, if academic performance is a function of time devoted to study, and if time devoted to study is associated with or reflects the marginal disutility of work, then successful applicants for entry will, on average, exhibit lesser disutility associated with work than will unsuccessful applicants or non-applicants.

[3]For example, earnings of academic faculty might be a linear function of publications, measured in pages. But if pages produced per hour decline with increases in hours, then the marginal wage rate of the academic will decline and will be less than his or her average wage rate.

Consider a professional practitioner confronting a demand function for services of the form

$$(2.1) \quad P = P(Q; Z_1)$$

where P is the price received per unit of service rendered,

Q is the quantity of services supplied, and

Z_1 is a vector of other variables influencing demand, including, for example, characteristics of the professional, potential customers, and the market.

This demand function is assumed to exhibit the usual property that

$$\partial P/\partial Q \leq 0.$$

Ignoring inputs other than the professional's own time, the production function for professional services can be expressed generally as

$$(2.2) \quad Q = Q(H_p; Z_2)$$

where H_p denotes time devoted to professional practice, and

Z_2 is a vector of other factors influencing production.

At least over the relevant range, the marginal productivity of practice time is assumed to be positive, that is,

$$\delta Q/\delta H_p > 0.$$

In the absence of unambiguous measures of price and output, it is necessary to focus analysis on practice earnings, the product of price and output, that is,

$$(2.3) \quad Y_N = P \bullet Q = P(Q; Z_1) \bullet Q(H_p; Z_2)$$

where Y_N is net practice earnings.[4]

[4]Direct estimation of a net earnings function is also necessary if returns to physician training are to be determined. Primary sources of data on earnings of non-physicians permit only the estimation of net earnings functions. Thus, comparability between the earnings function estimates for physicians and non-physicians requires recourse to the simplified formulation.

Derivation of the reduced-form earnings function requires the specification of functional forms for the demand and production functions. Because the productivity of time devoted to practice may be a complex function of the size of the practice, the standard Cobb-Douglas and CES production functions are excessively restrictive. A sufficiently general form for present purposes is

$$(2.4) \quad Q = H_p^{\alpha} e^{\beta_0 + \beta_1 H_p + \beta_2 Z_2}.$$

The marginal product of time devoted to practice, then, is,

$$\partial Q/\partial H_p = (\alpha/H_p + \beta_1)\, Q.$$

Conjoining this production function with a constant elasticity of demand function, that is,

$$(2.5) \quad P = Q^{-\alpha_1} e^{\alpha_0 + \alpha_2 Z_1},$$

the following reduced-form net earnings function is obtained:

$$(2.6) \quad Y_N = P \cdot Q = H_p^{\alpha(1-\alpha_1)} e^{[(\beta_0 - \alpha_1 \beta_0 + \alpha_0) + \beta_1 (1-\alpha_1) H_p + \beta_2 (1-\alpha_1) Z_2 + \alpha_2 Z_1]} = H_p^{c_1} e^{c_0 + c_2 H_p + c_3 X}$$

where $X = [Z_1, Z_2]$.

In the absence of data which would permit simultaneous estimation of the demand and production functions, it will be impossible to identify the underlying structural parameters of these functions, restricting attention to the reduced form parameters c_i.[5]

The marginal wage rate in this model is

$$(2.7) \quad w_m = \partial Y_N/\partial H_p = (c_1/H_p + c_2)\, Y_N$$

which will vary with variations in hours worked. As can be easily demonstrated, the marginal wage rate will be constant, equal to the average wage, if and only if $c_2 = 0$ and $c_1 = 1$, which would be implied only by a perfectly competitive market for professional services ($\alpha_1 = 0$) and price independent of the quantity of services supplied by the individual practitioner) conjoined with a homogeneous production function exhibiting constant returns to scale ($\beta_1 = 0$ and $\alpha = 1$). For reasons discussed above, these conditions are unlikely to be met in the case of independent professional practice. An elasticity of demand less than unity would imply decreasing returns to practice time even if the production function itself were homogeneous of degree one. Fatigue and related effects provide further reasons for anticipating a non-homogeneous earnings function ($c_2 < 0$). Thus, a declining marginal wage rate, with $c_1 < 1$ and $c_2 < 0$, is expected.

[5]This is a simplification of the more complex hours-experience interactions permitted in the empirical analysis. However, this simplification facilitates the present discussion without abstracting from the central issue.

As developed thus far, the model abstracts from a potentially significant source of variation in the hours-earnings relationship, that is, from the effects of age or experience on the marginal physical or revenue product of time devoted to practice. In fact, these effects are ignored in the conventional earnings function analysis, in which age or experience is subsumed in the vector X, implying that the earnings function (with respect to any other variable in the model) is shifted in a logarithmically parallel manner. Especially with respect to the effect of hours on earnings, however, this treatment is excessively restrictive.

A sufficiently general formulation would permit nonhomogeneous effects of age or experience on earnings and on the hours-earnings relationship. Consider a net earnings function of the form

$$(2.8)\quad Y_N = H_p^{(a_0 + a_1 E + a_2 E^2)}\, e^{[b_0 + b_1 E + b_2 E^2 + b_3 H + b_4 HE + b_5 HE^2 + b_6 X]}$$

where E is years of labor force experience (active professional practice).

This generalized form permits a highly flexible relationship between the marginal wage rate, hours, earnings, and experience. The marginal wage rate is

$$(2.9)\quad w_m = \frac{\partial Y_N}{\partial H} = \left[\frac{(a_0 + a_1E + a_2E^2)}{H_p} + (b_3 + b_4E + b_5E^2)\right]Y_N.$$

Thus, the marginal wage rate may rise or decline with increased hours of work, and experience may serve to raise or lower the marginal wage rate, not necessarily equiproportionately at all levels of hours.

Given estimates of the earnings functions for professions i and j, the returns to the choice of profession i over profession j can be estimated by evaluating the earnings function for specified (for example, mean) values of all relevant variables. Denote mean age of entry into profession i as $\bar{A}_{0i}$ and mean hours in i at age a as $\bar{H}_{ia}$. Mean experience at age a is

$$(2.10)\quad \bar{E}_{ia} = a - \bar{A}_{0i}.$$

With this information and the mean value $\bar{X}_{ia}$, earnings at age a of a person with mean characteristics in profession i, denoted $\bar{Y}_{Nia}$ can be computed from equation 2.8.

The gross capital value of the choice of profession i over profession j is determined by summing over all ages the discounted earnings differentials between the two alternative professions. The most common estimate of the gross returns to occupational choice makes no adjustments for hours of work differentials, using the measure

$$V^U_{ij} = \sum_{a=L}^{U} (S_{iLa}\ \bar{Y}_{Nia} - S_{jLa}\ \bar{Y}_{Nja})\,(1 + r)^{-(a-L)}$$

where L represents the lower bound of the working lifetime,

U represents the upper bound of the working lifetime,

r is the discount rate

S_{iLa} is the probability that a profession i incumbent will survive from age L to age a, and

V^U_{ij} is the estimate of the gross capital value at age L of the choice of profession i over profession j, unadjusted (superscript U) for hours of work differentials between the alternative professions.

The most common hours-of-work adjusted measures found in the literature simply adjust earnings proportionately in one of the two occupations for estimated hours of work differentials, assuming that earnings are a linear function of hours. A Paasche adjustment scales earnings in the alternative occupation j for the i, j hours of work differential, resulting in the estimate

$$V^{ALP}_{ij} = \sum_{a=L}^{U} (S_{iLa}\ \bar{Y}_{Nia} - S_{jLa}\bar{Y}_{Nja}\frac{\bar{H}_{ia}}{\bar{H}_{ja}})\,(1 + r)^{-(a-L)}$$

where $\bar{H}_{ia}$ is estimated hours in occupation i at age a, and

V^{ALP}_{ij} is the adjusted (superscript A) estimate assuming linearity (superscript L) in the Paasche (superscript P) adjustment for hours differentials.

Because the representative worker in occupation j could, if he or she wished, work $\bar{H}_{ia}$ hours, in any year this measure will provide an upward-biased estimate of differential earnings in occupation i, inappropriately assuming that earnings are in fact a linear function of hours.

The corresponding Laspeyre adjustment, still assuming linearity of earnings as a function of hours, involves scaling earnings in occupation i by the i, j hours of work differential, resulting in the estimate

$$V^{ALL}_{ij} = \sum_{a=L}^{U} (S_{iLa}\ \bar{Y}_{Nia}\ \frac{\bar{H}_{ja}}{\bar{H}_{ia}} - S_{jLa}\ \bar{Y}_{Nja})\,(1 + r)^{-(a-L)}$$

where V^{ALL}_{ij} is the adjusted capital value estimate assuming linearity of earnings with hours and incorporating a Laspeyre (final superscript L) adjustment for hours differentials.

Because the representative worker in i is also free to work H_{ja} hours if he/she wishes, this estimate in any year will incorporate a downward biased estimate of earnings differentials, ignoring wealth effects, at least on the assumption of hours-earnings linearity.

If earnings are in fact not a linear function of hours, then these two adjusted estimates may both be seriously biased. In fact, nonlinearity of earnings, with respect to hours, is the dominant pattern in the professional occupations examined. Thus, more appropriate measures can be obtained by explicitly taking into account this observed nonlinearity.

The nonlinear (superscript N) Paasche-adjusted estimate is

$$V_{ij}^{ANP} = \sum_{a=L}^{U} (S_{iLa} \overline{Y}_{Nia} - S_{jLa} \overline{Y}_{Nja}(\overline{H}_{ia}))(1+r)^{-(a-L)}$$

where $\overline{Y}_{Nja}(H_{ia})$ is given by the evaluation of the estimated earnings function for occupation j at estimated hours in occupation i, and

V_{ij}^{ANP} is the adjusted, nonlinear Paasche estimate of the capital value of the choice of occupation i over j.

As in the case of the linear Paasche estimate, this measure will be based on an upward biased estimate of the differential in any year.

The alternative Laspeyre-adjusted nonlinear estimate is

$$V_{ij}^{ANL} = \sum_{a=L}^{U} (S_{iLa} \overline{Y}_{Nia}(\overline{H}_{ja}) - S_{jLa} \overline{Y}_{Nja})(1+r)^{-(a-L)}$$

where V_{ij}^{ANL} is the adjusted nonlinear Laspeyre capital value estimate.

Also, as in the case of the linear Laspeyre estimate, this measure will rest upon a downward biased estimate of the differential in any year.

These various alternative measures represent estimates of the gross, rather than net, capital values of the returns to the choice of profession i over profession j because different out-of-pocket, schooling-cum-training costs have not been taken into account. However, if one assumes that, prior to the completion of the schooling or training period, earnings are in fact zero, that is, if $\overline{Y}_{Nia} = 0$ for all $a \leq L + F_i$, where F_i is the years of schooling required after age L for entry into profession i, then differential foregone earnings associated with the choice of profession i over profession j will have been taken into account in the estimates. Also, since foregone earnings differentials have been taken into account, no adjustment of the resulting estimates is required for room, board, and other living costs over the schooling or training period. Thus, the net capital value of the choice of i over j can be obtained simply by deducting from the gross capital value only the present value of differential costs of schooling *per se* (out-of-pocket costs of tuition, fees, books, etc.)

The net capital values associated with the choice of profession i over profession j, obtained by deducting the present value of differential schooling costs from the alternative gross capital value estimates developed above, can be argued to be the most appropriate measure of the returns to i over j because they represent the amounts that would have to be paid to a would-be entrant into profession i to compensate him/her if i were foreclosed and she/he were forced to enter profession j. Although the compensating net capital values are more appropriate as measures of returns in a context of an either/or choice, it is also possible to derive from these estimates net internal rates of return to the choice of i over j by finding that value of the discount rate r which results in a net capital value estimate of zero.

Because the earnings functions will be estimated from cross-sectional data, the net internal rates of return and the assumed discount rates on the basis of which the net capital value estimates are derived correspond to what Tobin (1971) has referred to as the "income rate of interest." If the estimated earnings profiles shift upward over time due to (real or inflationary) secular earnings growth, then the nominal earnings experience of an individual will be defined by successively higher-points (due to increased age and experience) on progressively higher earnings profiles (due to secular earnings growth). Consider a person with a year of experience in the base period (t = 0) earning Y_{ao}. If nominal earnings (at all levels of experience) are increasing at a secular rate, then the nominal earnings of an individual with a year of experience who enters the labor force at time t = 1 will be

$$Y_{ao}(1+d)^a.$$

The present value of these earnings at time t = 0 discounting at a nominal interest rate R, will be

$$PV_{ao} = (Y_{ao}(1+d)^a(1+R)^{-a}$$

$$\simeq Y_{ao}(1+R-d)^{-a} = Y_{ao}(1+r)^{-a}$$

where $r = R - d$ is the income-growth-adjusted discount rate.

The use of r, then, permits one to abstract from or to ignore the rate of secular increase in nominal earnings. Thus, if an income-growth-adjusted rate (r) of 5 percent is assumed, this would correspond to a nominal discount rate (R) of 15 percent if a rate of secular income growth (d) of 10 percent is assumed.

The mortality adjustments incorporated in the estimates of returns to occupational choice also require further consideration. Age-specific mortality rates differ significantly across occupations. While mortality rates are generally significantly lower in professional occupations than for the population at large, there are great differences across professions. The issue is whether these occupation-specific mortality adjustments should be incorporated in the estimation of returns to occupational choice. If the entire difference in mortality

experience were attributable to occupation *per se*, this would be an appropriate procedure. However, to a greater or lesser extent, these differences in mortality experience undoubtedly reflect the selection or self-selection into occupations of persons with occupation-independent mortality probabilities which differ systematically from those of the population at large and from those of entrants into alternative occupations.

If, in fact, *ex ante* mortality probabilities differ significantly across entrants into alternative occupations, then it is probably also the case that mortality expectations of marginal entrants into an occupation will tend toward those of the population at large. Because occupations differ in the life cycle profile of earnings, it is necessary to adjust expected future earnings for survival probabilities, but the derivation of appropriate survival probabilities is ambiguous.

For the representative incumbent in any occupation, the issue is one of *ex post* occupational versus *ex ante* selection differences in mortality/survival prospects. At one extreme, if observed inter-occupational differences in mortality are causally related to occupation, lifetime earnings in each occupation should be adjusted for that occupation's mortality experience. If the effects derive entirely from selection into alternative occupations of persons with systematically different mortality prospects, then the returns to choice of occupation j over i for a j incumbent should be estimated on the basis of earnings in both i and j adjusted for j mortality. For the marginal entrant, if the observed mean differentials are due to selection, while the marginal entrant's prospects converge toward those for the population, an occupation-independent adjustment would be appropriate. To indicate the effects of mortality adjustments on estimated returns to physician training, a range of alternative adjustments is employed empirically.

Estimated Professional Earnings Functions

In this section, I estimate the reduced-form professional earnings function developed above (equation 2.8) for 15 professional occupations and 10 medical specialties, using cross-section data. The professional occupation estimates are based upon the 1977 Annual Demographic File of the Current Population Survey (CPS), which provides information on individual hours and earnings for 1976. I estimate specialty-specific physician earnings functions with data from the 1976 Physician Practice Cost and Income Survey of the Health Care Financing Administration (HCFA). In the following section, I use the estimated earnings functions to estimate returns to physician training and to medical specialization.

Because of the complexity and multiplicity of the effects of hours and experience on earnings marginal wage rates in equation 2.8, collinearity of the various experience and hours terms and interactions precludes estimation of the model in its most general form. Thus, the estimated models in each case represent more or less parsimonious versions of the general model. All empirical applications include estimation of log-of-hours, experience, and experience-squared coefficients, a_0, b_1, and b_2. The coefficients of hours, b_3, is included only if it is found to be statistically significant, except as noted below. Because of severe collinearity, it was impossible in all cases to estimate both pairs of hours-experience interaction coefficients, (a_1, a_2) and (b_4, b_5), simultaneously. Thus, the statistically more significant pair of coefficients was estimated if at least one pair was significant. If b_4 and b_5 (the coefficients of the hours-experience interaction terms) were estimated, b_3 (the coefficient of hours) was also estimated, even if it was not significant.

The exploratory nature, qualifications, and limitations of the empirical analysis should be stressed at the outset. As in the case of all earnings functions estimated from cross-sectional data, the estimates of "life cycle effects" (experience and experience-hours coefficients) may confuse true life cycle and cohort effects. Also, in estimating the earnings functions hours of work, experience and other explanatory variables are assumed to be exogenously determined. In fact, many of these variables are determined simultaneously with, and in response to their effects on, earnings. Thus, the estimated coefficients are subject to simultaneous equations bias. Although the direction and degree of bias is unknown, its probable presence should be kept in mind. Notwithstanding these qualifications, the results indicate the importance of explicitly taking into account the variation in marginal earnings with hours and experience and confirm the untenability of the conventional assumption of a constant, average-equal-to-marginal wage rate.

To achieve adequate sample size in the CPS analysis, I grouped the detailed professional, technical, and managerial occupations (identified by 1970 Census occupation codes) into 15 aggregate occupation groups, the composition and characteristics of which are summarized in Table 3.1. With the exception of natural scientists and health technicians, for which I obtained samples sizes of 152 and 68, respectively, this aggregation resulted in sample sizes of in excess of 200.

On the assumption that earnings within an occupation are approximately distributed according to the log normal distribution, the log of median earnings will be roughly equal to the mean of the log of earnings. Thus, Table 3.1 presents the approximate median earnings by occupation obtained by evaluating the mean of the log of earnings. To indicate the dispersion of earnings within each occupation, the mean of the log, plus and minus one standard deviation, is also evaluated (in parentheses). Again on the assumption of a log normal distribution, this range will include approximately two-thirds of the observations. References to log values in all cases refer to natural logarithms.

TABLE 3.1

Summary Description of the 1976 Professional Occupation Samples

1970 Census Occ. Codes	Occupation	Number of Observations	1976 Annual Earnings	1976 Annual Hours
001	(1) Accountants	363	$16,469 (9,833 - 27,585)	2,193 (337)
006-023	(2) Engineers	793	20,209 (13,393 - 29,398)	2,231 (378)
030-031	(3) Lawyers and judges	245	21,973 (7,895 - 61,156)	2,439 (543)
042-054	(4) Natural scientists	152	15,370 (7,911 - 28,860)	2,212 (416)
065	(5) Physicians	205	34,746 (20,161 - 59,881)	2,829 (790)
080-085	(6) Health technicians	68	10,168 (6,024 - 17,162)	2,180 (520)
102-140	(7) College faculty	236	16,556 (9,693 - 28,279)	2,381 (678)
141-145	(8) Teachers (ex college)	589	13,387 (9,058 - 19,784)	2,297 (457)
150-162	(9) Eng. and science technicians	452	13,514 (8,892 - 20,538)	2,149 (302)
201, 213, 215, 222	(10) Public administrators	316	16,066 (9,869 - 26,155)	2,163 (275)
202	(11) Bank officers	270	17,070 (10,708 - 27,212)	2,255 (393)
212,235,240	(12) Health and ed. admin.	242	19,776 (13,252 - 29,511)	2,413 (439)
211,216,220, 221,223,224, 245,246	(13) Misc. managers and officials (ex trade-related)	3380	14,625 (5,290 - 40,431)	2,494 (578)
203,205,210, 225,230,231, 233	(14) Trade-related managers	794	13,319 (4,670 - 37,983)	2,457 (582)
003-005,034-036, 055	(15) Computer and math spec.	238	17,310 (11,914 - 25,149)	2,172 (294)

Source: Current Population Survey 1977 Annual Demographic File

Earnings vary substantially both across and within occupations. Median earnings range from $10,168 for health technicians and $13,319 for trade-related managers to $21,973 for lawyers and $34,746 for physicians. Using the ratio of the upper to lower bounds of the plus and minus one standard deviation range as an indicator of the dispersion of earnings within an occupation, the degree of intra-occupational variation ranges from 2.1 for computer and mathematical specialists to 8.1 for trade-related managers. This measure (denoted INDEX) and the standard deviation of the log distribution from which INDEX is derived (INDEX = $e^{2\sigma}$, where σ is the log standard deviation), ranked from lowest to highest, are:

	Index	Log Stan. Dev.
Computer and mathematical specialists	2.1	.37
Engineers	2.2	.37
Non-college teachers	2.2	.39
Health and education administration	2.2	.40
Engineering and science technicians	2.3	.42
Bank officers	2.5	.47
Public administrators	2.6	.49
Accountants	2.8	.52
Health technicians	2.9	.52
College faculty	2.9	.54
Physicians	3.0	.54
Natural scientists	3.8	.66
Misc. managers and officials	7.6	1.02
Lawyers and judges	7.7	1.02
Trade-related managers	8.1	1.05

Because sales-related occupations have been excluded, the occupational groups are concentrated at the lower end of the intra-occupational variance distribution.

Annual hours of work, for which means and standard deviations are also reported in Table 3.1, exhibit similar between- and within-occupation variability. Mean hours range from 2,149 for engineering and science technicians and 2,163 for public administrators to 2,494 for miscellaneous managers and officials and 2,829 for physicians. As the measures of intra-occupation variation in hours, standard deviations are highest for physicians (790) and college faculty (678) and are lowest for computer and mathematical specialists (294) and public administrators (275).

This gross variability in earnings and hours, while of potential interest, fails to account for the covariance of hours and earnings and for variations in schooling, experience, etc. For this purpose it is necessary to turn to the estimated earnings functions, presented in Table 3.2. The dependent variable in each case is the natural logarithm of reported earnings in 1976. Explanatory variables potentially included in the estimated functions are:

Annual hours (in thousands; ln)
Annual hours (in thousands)
Experience (age minus years of schooling minus six, in decades)
Experience squared
Experience—log of hours of interaction
Experience squared—log of hours interaction
Experience—hours interaction
Experience squared—hours interaction
Weeks worked (ln)
Years of schooling attended
Dummy variable for completion of 16 or more years of school
Years of school attended, conditional on completion of 16 or more
Dummy variable for self-employment
Dummy variable for SMSA residence
Dummy variable for SMSA central-city residence.

The self-employment and various years of schooling variables were included only when I observed intra-occupational variation in these variables.

Considering that I estimated these earnings functions on the basis of cross-sectional observtions, the explanatory power of the estimated equations is remarkably high, with coefficients of determination (R^2) ranging from 0.63 (college faculty) to 0.17 (trade-related managers). Only in the last case does the R^2 fall below 0.3, and for seven of the 15 occupational groups, it exceeds 0.4.

Surprisingly in light of cost-of-living and other urban-rural differences, the SMSA residence dummy variable is not significant (at the 5 percent level) for engineers, lawyers, natural scientists, physicians, health technicians, engineering and science technicians, and computer and mathematical specialists. Less surprisingly, since it relates to residence rather than place of work, the central city dummy variable is rarely significant.

The self-employment dummy variable is significantly negative for both miscellaneous and trade-related managers. For physicians, lawyers, and accountants, this variable is totally insignificant. Thus, there is no evidence in these data that mode of practice influences professional earnings.

Interestingly, having controlled for occupation there is evidence of only attenuated returns to schooling. Years of schooling is significant for engineers, college faculty, other teachers, engineering and science technicians, miscellaneous managers, trade-related managers, and computer and mathematical specialists, with returns to a year of schooling ranging between 3 and 8 percent in annual earnings for these occupational groups. Completion of schooling beyond the collegiate level has a significant differential effect on earnings only for public administrators, bank officers, and health and educational administrators. In these three occupations, however, there is no return to school below the college-completion level.

TABLE 3.2
Estimated 1976 CPS Earnings Equations

Occupation Variable	(1) Accountants	(2) Engineers	(3) Lawyers and Judges	(4) N. Scientists	(5) Physicians	(6) Health Technicians	(7) College Faculty	(8) Teachers (ex college)	(9) Eng. and Science Technicians	(10) Public Administrators	(11) Bank Officers	(12) Health and Ed. Administration	(13) Misc. Managers	(14) Trade-related Managers	(15) Computer and Math
Annual Hours (ln)	2.945 (0.885)	0.506 (0.079)	8.818 (1.445)	0.324 (0.226)	0.877 (0.676)	1.026 (0.248)	2.022 (0.312)	2.335 (0.384)	4.183 (0.468)	6.26 (1.32)	0.508 (0.814)	3.978 (0.861)	3.56 (0.450)	3.363 (0.891)	4.708 (1.284)
Annual Hours	-1.347 (0.461)		-3.002 (0.510)		-0.469 (0.242)		-0.408 (0.148)	-0.668 (0.163)	-1.446 (0.208)	-2.397 (0.561)	0.079 (0.369)	-1.431 (0.346)	-1.023 (0.157)	-1.089 (0.337)	-1.800 (0.530)
Experience	-1.021 (0.352)	0.432 (0.033)	0.073 (0.573)	0.919 (0.113)	0.199 (0.321)	0.342 (0.177)	1.027 (0.187)	0.961 (0.139)	0.456 (0.044)	0.499 (0.068)	1.195 (0.349)	0.460 (0.081)	1.192 (0.175)	0.422 (0.089)	0.373 (0.073)
Experience Squared	0.313 (0.076)	-0.072 (0.007)	0.114 (0.113)	-0.178 (0.029)	-0.030 (0.069)	-0.057 (0.045)	-0.192 (0.052)	-0.213 (0.032)	-0.077 (0.010)	-0.080 (0.013)	-0.292 (0.071)	-0.080 (0.019)	-0.209 (0.032)	-0.069 (0.019)	-0.055 (0.018)
Exp *ln H			0.726 (0.647)				-0.681 (0.234)	-0.653 (0.181)			-0.825 (0.433)		-0.736 (0.199)		
Exp Squared *ln H			-0.292 (0.128)				0.141 (.063)	0.164 (0.044)			0.254 (0.088)		0.134 (0.036)		
Exp *H	0.703 (0.159)				0.250 (0.105)										
Exp Squared *H	-0.183 (0.034)				-0.058 (0.023)										
Weeks Worked (ln)	0.821 (0.832)	1.605 (0.378)	0.897 (2.897)	6.601 (1.433)	-0.892 (0.993)	1.486 (3.652)	0.180 (0.481)	-0.227 (0.251)	-0.193 (0.383)	-0.278 (0.728)	1.971 (0.998)	-0.002 (0.580)	0.911 (0.464)	0.600 (0.976)	-1.350 (1.467)
Yrs of Sch	0.000 (0.022)	0.050 (0.013)		0.097 (0.065)		0.061 (0.045)	0.080 (0.017)	0.059 (0.007)	0.031 (0.012)	0.022 (0.017)	-0.004 (0.020)	-0.014 (0.027)	0.064 (0.010)	0.065 (0.023)	0.074 (0.024)
Compl. 16+ Yrs of Sch (0,1)	-0.444 (0.487)	-0.139 (0.242)		0.708 (1.003)		0.694 (1.444)			-0.989 (0.629)	-0.991 (0.516)	-1.067 (0.474)	-1.091 (0.511)	0.733 (0.446)	0.916 (1.073)	0.603 (0.487)
Yrs of Sch, Comp. 16+	0.048 (0.032)	0.011 (0.016)		-0.058 (0.071)		-0.046 (0.090)			0.054 (0.038)	0.075 (0.032)	0.089 (0.031)	0.082 (0.034)	-0.040 (0.027)	-0.047 (0.066)	-0.036 (0.032)
Self-Employed (0,1)	0.062 (0.060)		-0.132 (0.118)		0.088 (0.071)								-0.300 (0.035)	-0.618 (0.103)	
SMSA (0,1)	0.137 (0.051)	0.040 (0.025)	0.180 (0.132)	0.106 (0.087)	0.091 (0.077)	-0.047 (0.153)	0.149 (0.049)	0.128 (0.028)	0.010 (0.032)	0.197 (0.048)	0.185 (0.047)	0.193 (0.046)	0.173 (0.037)	0.209 (0.079)	0.089 (0.053)
SMSA Cent. City (0,1)	-0.041 (0.053)	-0.044 (0.029)	-0.239 (0.139)	-0.159 (0.098)	0.040 (0.078)	-0.017 (0.126)	0.077 (0.065)	-0.062 (0.036)	-0.065 (0.041)	-0.014 (0.061)	-0.110 (0.058)	-0.105 (0.064)	-0.016 (0.045)	-0.105 (0.090)	-0.079 (0.052)
R^2	0.429	0.365	0.332	0.556	0.370	0.390	0.631	0.432	0.486	0.427	0.498	0.374	0.138	0.170	0.321

Although individual hours, experience, and hours-experience interaction variables are occasionally insignificant, these variables generally exhibit high levels of statistical significance. The log of hours, included in all equations, is insignificant only for natural scientists, physicians, and bank officers. However, for physicians and bank officers the hours-experience interaction variables are highly significant. One or both of the interaction variables are also significant for lawyers, college faculty, other teachers, and miscellaneous managers. Either hours (non-logged) or the hours-(non-logged) experience interaction variables are significant for accountants, lawyers, physicians, college faculty, other teachers, science and engineering technicians, public administrators, health and educational administrators, miscellaneous and trade-related managers, and computer specialists, for all of whom the elasticity of earnings with respect to hours declines with increases in annual hours of work. Thus, a constant elasticity is observed only for engineers, natural scientists, health technicians, and bank officers. However, only for health technicians is an elasticity of unity observed (implying a constant marginal equal to average wage). In all other cases, the marginal and average wage rates decline with increases in hours of work, at least over the relevant range.

Because of the multiplicity of hours, experience, and schooling variables in the estimated equations, significance tests of individual coefficients fail to indicate the joint significance of the variables in each of these groups. For this purpose, Table 3.3 provides joint significance tests of (a) all variables incorporating annual hours, (b) all variables incorporating experience, and (c) all variables incorporating years of schooling. Hours-experience interaction terms, in any form, are included in both of the first two tests. In the case of lawyers and physicians, for which no variance in schooling was observed, the third test is not performed.

Together the hours variables are highly significant for all occupations other than natural scientists and physicians; for the former the schooling variables are also jointly insignificant. Schooling variables are insignificant for health technicians as well, and for this occupation the experience variables are jointly significant at only the 4 percent level. In all other cases, the joint tests indicate significance at less than the 1 percent level.

As expected, in all cases the experience variables (either alone or interacting with the hours variables) imply earnings which at first increase and eventually decline with experience.

To indicate the effects of variations in age, hours of work, and levels of schooling on marginal wage rates, Table 3.4 presents marginal wage rates at three ages (30, 45, and 60) for four hypothetical schooling levels (modal years, 12, 16, and 20 years) at four levels of annual hours (at estimated actual hours at each age and at 1,900, 2,300 and 2,700 hours). Since experience is proxied by age and years of schooling, labor force experience is assumed to begin at age 21 for persons with 14 years of schooling, at age 23 for persons with 16 years of schooling, and at age 27 for persons with 20 years of schooling. Also, the hypothetical individual is assumed to work 50 weeks per year and is a non-central-city resident of an SMSA. Self-employment, observed in the case of 51 percent of lawyers and 60 percent of physicians, is assumed for these two occupations. While increases in schooling invariably increase marginal earnings at more advanced ages (although only slightly in many cases), the necessarily negative relationship between years of schooling and experience at any age often results in declines in marginal wage rates at younger ages. Holding hours constant, marginal wages rise and then decline with age in all occupations other than college and non-college teachers and miscellaneous managers, for which a decline and then a rise is observed. In all cases other than health technicians (for which the marginal wage is effectively constant), marginal wage rates decline with increases in annual hours worked.

Perhaps the most startling finding is the extremely low marginal wage rate confronted by physicians. At the estimated actual hours and modal years of schooling,the physician's marginal wage rate is lower at all ages than that of lawyers, health technicians, engineering and science technicians, public administrators, trade-related managers and computer and mathematical specialists. The highest marginal wage rates are clearly those of lawyers, which exceed $20 per hour between the ages of 40 and 50. By comparison, the marginal physician wage rate rises from $3.70 at age 40 to $5.28 at age 50. As discussed below, this extremely low marginal wage rate of physicians is also observed for individual medical specialties.

One seemingly anomalous finding deserves specific note. This is the negative marginal wage rate at the estimated hours observed in the cases of older accountants and young and old physicians. There is no conceptual difficulty associated with a negative marginal wage rate. Efficiency has fallen so low that total output actually declines, the demand curve for the individual's services is inelastic (for example, an older practitioner whose established clientele is contracting, requiring that he cut fees drastically in order to obtain patrons to occupy usual working hours), or the need for input other than own time has begun to rise more than proportionately with increases in hours. These explanations may well apply to the negative estimated marginal wage found for older accountants and physicians.

However, these explanations do not seem compelling with reference to the negative marginal wage rates estimated for younger physicians. Here the marginal wage rate at the estimated actual level of hours is negative for the first seven years after the receipt of a medical degree, becoming negative at between 1,600 and 2,000 hours at age 27, 2,000 and 2,400 at ages 28 to 30, and 2,400 and 2,800 hours at ages 31 to 33.

TABLE 3.3

Joint Significance Tests of the Hours, Experience, and Schooling Variables

Occupation	Hours*		Experience*		Schooling	
	F(d.f.)	Sig. (%)	F(d.f.)	Sig. (%)	F(d.f.)	Sig. (%)
Accountants	11.5(4,349)	<1%	36.8(4,349)	<1%	19.3(3,349)	<1%
Engineers	40.8(1,783)	<1	127.8(2,783)	<1	46.7(3,783)	<1
Lawyers and Judges	16.3(4,234)	<1	12.4(4,234)	<1	N.E.	
Natural Scientists	2.0(1,142)	16	49.6(2,142)	<1	1.7(3,142)	17
Physicians	1.7(4,194)	16	20.7(4,194)	<1	N.E.	
Health Technicians	17.1(1,58)	<1	3.5(2,58)	4	0.9(3,58)	45
College Faculty	22.9(4,225)	<1	26.5(4,225)	<1	22.7(1,225)	<1
Teachers (ex college)	15.7(4,578)	<1	53.1(4,578)	<1	67.8(1,578)	<1
Eng. and Science Technicians	63.6(2,441)	<1	78.6(2,441)	<1	4.5(3,441)	<1
Public Administrators	15.0(2,305)	<1	32.0(2,305)	<1	23.4(3,305)	<1
Bank Officers	9.0(4,257)	<1	31.0(4,257)	<1	32.8(3,257)	<1
Health and Ed. Administrators	15.2(2,231)	<1	27.7(2,231)	<1	10.6(3,231)	<1
Misc. Managers and Officials (ex trade-related)	19.4(4,3366)	<1	44.8(4,3366)	<1	38.4(3,3366)	<1
Trade-related Managers	10.2(2,782)	<1	14.2(2,782)	<1	11.0(3,782)	<1
Computer and Math Spec.	8.2(2,227)	<1	29.0(2,227)	<1	13.1(3,227)	<1

N.E.: Not estimated, variables not included in basic equation.
*: Tested variables set includes hours-experience interactions.

TABLE 3.4

Occupation	Years of School	At Hypothetical Annual Hours Levels: Marginal Wage Rate by Annual Hours and Age, 1900 hrs, 30	1900 hrs, 45	1900 hrs, 60	2300 Hrs, 30	2300 Hrs, 45	2300 Hrs, 60	2700 Hrs, 30	2700 Hrs, 45	2700 Hrs, 60	Modal Years of School	At Estimated Annual Hours Levels: At Age 30, Actual Hrs	At Age 30, Mar. Wage	At Age 45, Actual Hrs	At Age 45, Mar. Wage	At Age 60, Actual Hrs	At Age 60, Mar. Wage
(1) Accountants	12	8.59	10.98	-1.16	7.28	9.14	-5.00	5.42	6.63	-6.51							
	16	8.98	15.16	5.07	6.43	14.07	-0.86	3.59	11.84	-4.88	16	2,199	7.13	2,225	14.96	2,101	1.88
	20	6.54	17.93	11.81	3.02	16.67	5.88	-0.07	14.07	0.55							
(2) Engineers	12	3.65	4.57	4.14	3.32	4.16	3.76	3.07	3.84	3.48							
	16	4.13	5.64	5.57	3.76	5.14	5.07	3.47	4.74	4.68	16	2,221	3.82	2,219	5.23	2,178	5.20
	20	4.32	6.44	6.93	3.93	5.86	6.31	3.63	5.41	5.83							
(3) Lawyers	16	27.30	40.23	23.61	25.95	34.78	6.63	13.99	15.40	-8.94	19	2,467	15.40	2,567	21.96	2,310	11.66
	20	21.81	38.95	31.31	19.68	36.18	16.13	9.57	18.65	-2.79							
(4) Natural Scientists	12	2.00	2.80	1.76	1.75	2.46	1.55	1.57	2.21	1.39							
	16	1.90	3.30	2.57	1.67	2.90	2.26	1.50	2.60	2.03	20	2,320	1.41	2,283	3.06	2,244	2.99
	20	1.61	3.47	3.34	1.42	3.05	2.94	1.27	2.73	2.64							
(5) Physicians	20	1.93	10.14	6.21	0.08	7.63	3.55	-1.23	5.55	1.47	20	2,916	-1.93	2,833	5.38	2,813	1.06
(6) Health Technicians	12	4.28	5.11	4.72	4.30	5.14	4.74	4.32	5.16	4.76							
	16	4.77	6.11	6.04	4.80	6.14	6.07	4.82	6.16	6.10	14	2,250	4.08	2,205	5.75	1,960	5.47
	20	4.47	6.13	6.50	4.50	6.16	6.53	4.51	6.19	6.56							
(7) College Faculty	16	4.83	3.92	6.11	3.62	2.13	4.34	2.49	0.70	2.75	20	2,141	5.74	2,482	2.05	2,310	4.20
	20	6.40	5.05	6.64	5.27	2.90	4.26	4.07	1.15	2.24							
(8) Teachers (ex college)	16	4.05	3.66	6.78	2.17	1.21	4.71	0.57	-0.67	2.67	16	2,232	2.47	2,285	1.29	2,130	5.60
	20	5.25	4.08	6.92	3.36	1.27	4.10	1.61	-0.87	1.60							
(9) Eng and Science Technicians	12	8.69	10.93	9.71	5.34	6.72	5.97	1.62	2.04	1.81							
	16	7.66	10.58	10.31	4.71	6.51	6.34	1.43	1.97	1.92	14	2,110	7.09	2,117	9.27	2,014	9.68
	20	8.55	12.96	13.86	5.26	7.97	8.53	1.60	2.42	2.59							
(10) Public Administrators	12	10.31	13.67	12.66	4.75	6.30	5.84	-1.16	-1.54	-1.43	16	2,124	8.73	2,135	12.48	2,028	15.32
	16	2.11	17.67	18.01	5.58	8.14	8.30	-1.37	-1.99	-2.03							
	20	13.80	22.15	24.58	6.36	10.21	11.45	-1.56	-2.50	-2.80							
(11) Bank Officers	12	0.25	2.60	11.05	0.39	2.53	12.84	0.50	2.50	14.69	16	2,236	2.81	2,316	1.49	2,166	13.38
	16	1.38	1.35	12.80	1.41	1.48	13.67	1.45	1.59	14.57							
	20	3.34	0.13	12.17	3.22	0.52	12.19	3.17	0.80	12.34							
(12) Health and Ed Admin.	12	8.61	10.75	9.36	4.68	5.84	5.09	0.71	0.89	0.77	16	2,369	4.17	2,421	4.96	2,452	4.32
	16	9.05	12.44	11.92	4.92	6.76	6.48	0.75	1.03	0.98							
	20	9.61	14.54	15.34	5.23	7.90	8.34	0.79	1.20	1.27							
(13) Misc Managers and Officials (ex trade-related)	12	6.09	5.75	7.02	3.22	1.66	3.58	0.59	-1.54	0.48	14	2,387	3.34	2,424	0.69	2,251	4.09
	16	8.59	8.14	9.37	5.34	2.56	3.94	2.05	-1.86	-0.63							
	20	8.86	8.93	9.43	6.33	3.37	3.26	3.40	-1.19	-1.72							
(14) Trade-related Managers	12	7.63	9.57	8.78	5.14	6.45	5.92	2.40	3.01	2.76	14	2,356	5.04	2,413	6.15	2,207	7.78
	16	10.44	14.23	14.19	7.04	9.60	9.57	3.28	4.47	4.46							
	20	9.62	14.25	15.45	6.49	9.61	10.42	3.03	4.48	4.86							
(15) Computer and Math Spec.	12	8.90	11.31	11.23	3.88	4.93	4.89	-0.92	-1.17	-1.16	16	2,121	7.69	2,220	8.29	2,153	10.33
	16	11.03	14.97	15.88	4.81	6.52	6.92	-1.14	-1.54	-1.64							
	20	10.93	15.84	17.94	4.76	6.90	7.82	-1.13	-1.63	-1.85							

Because of the characteristics of the CPS data, it is not possible to identify the precise status of a young physician. At these ages, however, it is reasonable to assume that the physician is in training. In fact, the absolute levels of earnings observed are consistent with this conjecture. Thus it is more plausible to suggest that the negative marginal wage reflects a choice of activity and hours which involves a trade-off between current and future earnings. In exchange for a current sacrifice of earnings and leisure, the young physician obtains training which will produce higher future earnings. Obviously, only with longitudinal data would it be possible to explicitly test this hypothesis, but the observation of a negative marginal wage rate indicates the importance of explicitly taking into account time devoted to skill formation.

Changes in earnings over the life cycle represent the consequences of simultaneous changes in hours of work and marginal wage rates. These changes are summarized in Table 3.5, which indicates, by occupation, (a) the age at which earnings reach their peak, (b) hours, earnings, and the marginal wage rates at that age, and (c) ratios to these of their values at ages 30 and 65. For purposes of this table and of the analysis of returns to occupational choice in the following sections, the modal years of schooling in each occupation are assumed.

Earnings in these occupations peak between the mid-40s and mid-50s, with the peak coming latest for college faculty (at age 56) and earliest for health technicians (at age 43). In general, earnings at age 30 range between two-thirds and three-quarters of peak earnings, but for natural scientists, physicians, lawyers, and college faculty much greater life cycle earnings growth is observed between age 30 and the peak.

If annual hours were held constant (at 2,400), with two exceptions (accountants and health and education administrators) earnings would peak later than the ages actually observed, generally by two to four years. Thus, the earlier observed peak results from a decline in hours which begins sometime before the age of peak earnings at constant hours. Hours are very similar at age 30 and at the age of peak earnings, but between age of peak earnings and age 65 hours decline in all occupations other than college faculty, natural scientists, and engineers. Marginal wage comparisons between age 30, age of peak earnings, and age 65 show much more diverse patterns, although the general pattern (violated by college faculty, other teachers, health and education administrators, and miscellaneous managers) is for the marginal wage rate to rise between age 30 and age of peak earnings. Between the age of peak earnings and age 65, marginal wage rates decline in seven occupations and rise in eight.

In summary, life cycle earnings patterns clearly differ significantly across occupations, with widely varying and complex relationships observed between earnings, experience, and hours of work. Unless these differences are explicitly recognized, no meaningful comparisons of earnings across occupations are possible.

Due to the limitations of the CPS data, it was impossible in the preceding analysis to control for physician specialty in the estimation of the physician earnings function. Using the Health Care Financing Administration's (HFCA) 1976 Physician Practice Cost and Income Survey, I estimated specialty-specific net earnings functions on which basis I derived returns to specialization.

The 1976 HCFA survey of office-based physicians covered physicians in 17 primary specialties. Because of sample size constraints, these have been collapsed into 10 basic specialty groups. These groups are described in Table 3.6, which also presents approximate median earnings (obtained by evaluating the mean of the natural logarithm of net earnings from practice), the dispersion of earnings (evaluating the mean of the log of earnings plus and minus one standard deviation), and the mean and standard deviation of annual medical practice hours. Sample sizes range from 190 (allergy and dermatology) to 317 (psychiatry).

Mean earnings of the HCFA sample, $54,893 over all specialties, significantly exceed that of the CPS physician sample ($34,746). This difference may reflect a number of factors, for example, different specialty distributions and the systematic exclusion of salaried and non-office-based physicians in the HCFA sample. The most important difference between the two samples in this regard is the discrepancy in mean ages, 49.0 for the HCFA sample versus 44.4 for the CPS sample. This difference undoubtedly reflects primarily the exclusion of physicians in training (interns and residents) in the HCFA sample (since trainees are both non-office-based and salaried), a group included (but individually unidentifiable) in the CPS sample.

Approximate median earnings vary substantially across specialties, from $45,356 in psychiatry to $69,838 in neurological and orthopedic surgery. However, the variation in median earnings across medical specialties is substantially less than that observed across the diverse CPS occupations (from $10,168 for health technicians to $34,746 for physicians). More importantly, as would be expected, the dispersion of earnings within individual specialties is substantially less than that observed for the CPS physicians, as the following dispersion indices (upper divided by lower bound of the evaluated log mean plus and minus one standard deviation) and log standard deviations indicate:

	Index	Log Stan. Dev.
Pediatrics	2.2	.39
General surgery	2.4	.43
Internal medicine	2.5	.46
Psychiatry	2.5	.46
Ob/Gyn	2.5	.47
General/Family practice	2.5	.47
Neurological and Ortho surgery	2.6	.47
Cardiovac/Gastro/Urol	2.6	.48
Allergy/Dermatology	2.7	.49
Ophthalmology/Otolaryngology	2.8	.51
All CPS physicians	3.0	.54

Although the basic form of the net earnings function (equation 2.8) estimated for the HCFA sample is identical to that used in the CPS analysis, because of extreme collinearity, it was impossible to include in the estimated specialty-specific net earnings functions either (a) both annual hours and the natural logarithm of annual hours or (b) any of the hours-experience interaction terms included in the CPS analysis. Thus, the natural logarithm of net practice earnings is expressed as a linear function of the natural logarithm of annual hours, implying a constant (but not necessarily unitary) elasticity of earnings with respect to hours.

The explanatory variables, included in all specialty net earnings functions, are

- Annual hours (ln)
- Experience (Age minus age at receipt of MD, in decades)
- Experience squared
- Weeks worked (ln)
- Age at receipt of MD
- Dummy variable for solo practice
- Dummy variable for incorporated
- Dummy variable for greater than average hours in survey week
- Dummy variable for less than average hours in survey week
- Dummy variable for board certified

Although experience is still a proxy variable, in that actual years of medical practice experience are not known, this proxy is clearly superior to that employed in the CPS analysis. In the latter it was implicitly assumed that the individual entered school at age six and continued through without pause to the completion of the highest year of schooling reported (assumed in the case of medicine to be 20 years, since the CPS reports only 19 or more years of schooling as an open-ended maximum category). Here the actual date (year) of medical school graduation is known, and experience is defined as years subsequent to medical school graduation.

Age at medical school graduation is included to permit later graduation to shift the earnings function, on the hypothesis that later graduation (possibly reflecting greater difficulty in obtaining entry to medical school and completing degree requirements) will be reflected in lower earnings, all else being equal. The dichotomous solo and incorporated practice variables are intended to capture both the real effects of alternative modes of practice organization on demand, productivity, and earnings, and also the consequences of legal structure for reported earnings. Board certification is expected to have a positive effect on earnings, all else equal, through its effects on demand and on the nature of practice activity.

Annual hours are obtained by multiplying medical practice hours reported for the survey week by annual weeks reportedly devoted to practice. This approach, therefore, will magnify any discrepancy in hours between the survey week and a truly average week. For this reason, dummy variables (the greater or less than average hours variables) were included to reflect the stated relationship between the survey week and the average week.

The estimated specialty net earnings functions are presented in Table 3.7. With the exception of neurological and orthopedic surgery, experience is found to have substantial and in general statistically highly significant effects, first increasing and then reducing earnings. The failure of the experience variables to exhibit the expected signs in the case of neurological and orthopedic surgery may reflect the pronounced effects of obsolescence of skills and of the deterioration of physical capabilites with age in these specialties.

Conforming to the findings for the CPS physicians, the elasticity of earnings with respect to hours is remarkably low. In the cardiovascular/gastroenterology/urology specialty, a negative (but not statistically significant) elasticity is estimated. With the exception of psychiatry and ophthalmology/otolaryngology, for which positive elasticities of 0.6 and 0.5 are estimated, these elasticities never exceed 0.33 (ob/gyn) and fall as low as 0.1 (general surgery).

Holding annual hours constant, a statistically significant relationship between annual weeks of practice and earnings is found for neurological/orthopedic surgery and obstetrics/gynecology (negative) and for cardiovascular/gastroenterology/urology (positive), suggesting in the former economies of concentrating activity over shorter spans of time and the reverse in the latter.

The coefficient of the solo practice dummy variable is invariably negative and usually statistically significant, reducing reported earnings in excess of 10 percent and by as much as one-third in all specialties other than allergy/dermatology and ophthalmology/otolaryngology. Conversely, an incorporated practice is associated with increases in reported net earnings of between 4 and 24 percent, notwithstanding the fact that net earnings would be expected to be understated by incorporated practitioners (for example, as a result of reporting only salary and not corporate retained earnings).

TABLE 3.5

Professional Life Cycle Hours and Earnings Relationships

Occupation	At Estimated Actual Hours										At 2400 Hours				
	Age at Peak Earnings	Peak Earnings	Hours at Peak Earnings	Marg. Wages at Peak Earnings	Ratio to Peak Earnings Year Value						Age at Peak Earnings	Peak Earnings	Peak Wages	Ratio to Peak Earnings Year Value	
					Earnings at		Marg. Wage at		Hours at					Wage at	
					30	65	30	65	30	65				30	65
Accountants	49	24,178	2,194	13.52	.67	.88	.53	-.46	1.0	.95	48	26,813	12.63	.45	-.72
Engineers	51	23,570	2,191	5.44	.71	.89	.70	.88	1.01	1.01	52	24,696	5.20	.71	.88
Lawyers and Judges	46	40,511	2,556	21.95	.55	.68	.70	.20	.97	.87	50	37,436	25.04	.67	-.07
Natural Scientists	51	23,048	2,181	3.43	.43	.77	.41	.67	1.06	1.15	52	23,802	3.22	.43	.73
Physicians	50	52,571	2,905	5.28	.47	.63	-.37	-.17	1.0	.87	50	49,227	8.07	-.04	-.03
Health Technicians	43	12,412	2,244	5.67	.82	.79	.82	.90	1.0	.88	50	13,661	5.84	.80	.88
College Faculty	56	24,918	2,314	3.25	.55	.98	1.77	1.62	.92	1.05	57	25,209	2.99	1.66	1.79
Teachers (ex college)	48	17,302	2,270	1.74	.75	.72	1.42	4.21	.98	.90	50	17,521	1.37	1.27	4.33
Eng. and Science Technicians	47	17,573	2,103	9.53	.75	.79	.74	.93	1.0	.95	49	19,956	5.92	.75	.83
Public Administrators	51	24,116	2,114	13.67	.66	.80	.64	1.16	1.10	.92	53	27,018	5.77	.65	.90
Bank Officers	52	26,227	2,260	5.78	.64	.78	.24	3.06	.99	.93	56	27,356	9.46	.15	2.11
Health and Ed. Administrators	52	24,355	2,517	3.64	.69	.80	1.15	1.83	.94	.89	51	23,855	5.41	.71	.85
Misc. Managers and Officials (ex trade-related)	50	22,484	2,385	1.10	.69	.77	3.04	5.44	1.0	.91	50	22,499	0.96	3.38	4.06
Trade-related Managers	48	20,325	2,387	6.52	.75	.78	.79	1.21	.99	.89	50	20,490	6.41	.75	.86
Computer and Math Spec.	54	27,477	2,210	9.07	.75	.91	.85	1.31	.96	.94	56	28,845	4.66	.69	.96

TABLE 3.6

Summary Description of the 1976 Physician Specialty Samples

Primary Specialties	Occupation	No. of Observations	Annual Earnings	Annual Hours
5	General/Family Practice	304	$46,220(28,951 - 73,791)	3,035 (771)
6	General Surgery	280	58,240 (37,810 - 89,710)	3,044 (728)
7	Internal Medicine	231	54,211 (34,282 - 85,725)	3,008 (770)
11	Obstetrics/ Gynecology	294	62,709 (39,354 - 99,924)	2,961 (799)
15	Pediatric Surgery	250	47,771 (32,480 - 70,262)	2,928 (658)
16	Child Psychiatry/ Psychiatry	317	45,356 (28,626 - 71,861)	2,546 (665)
1 and 3	Allergy/Dermatology	190	55,604 (34,032 - 90,849)	2,343 (638)
2, 4, and 17	Cardiovascular/ Gastroenterology/ Urology	233	61,419 (37,933 - 99,446)	2,949 (697)
8 and 13	Neurological Surgery/Ortho-pedic Surgery	194	69,838 (43,635 - 111,776)	2,952 (747)
12 and 14	Ophthalmology/ Otolaryngology	216	53,999 (32,519 - 89,666)	2,530 (705)
	Total Sample	2,509	54,893	2,842

Note: The following specialties, surveyed independently, have been grouped together: Allergy and Dermatology; Neurological Surgery and Orthopedic Surgery; Ophthalmology and Otolaryngology; and Cardiovascular, Gastroenterology, and Urology.

Source: 1976 HCFA Practice Cost and Income Survey

TABLE 3.7

Estimated 1976 HCFA Physician Net Earnings Equations

Variable	(1) General Family Practice	(2) General Surgery	(3) Internal Medicine	(4) Obstetrics/ Gynecology	(5) Pediatric Surgery/ Pediatrics	(6) Child Psychiatry/ Psychiatry	(7) Allergy/ Dermatology	(8) Cardiovascular/ Gastroenterology/ Urology	(9) Neurological Surgery/Orthopedic Surgery	(10) Ophthalmology/ Otolaryngology
Experience	.3155	.2780	.3097	.3065	.3116	.2271	.2271	.5844	-.1490	2879
	(.1071)	(.1324)	(.1188)	(.1432)	(.1123)	(.1255)	(.1586)	(.1448)	(.2240)	(.1574)
Experience Squared	-.0766	-.0519	-.0792	-.0819	-.0732	-.0492	-.0592	-.1091	.0090	-.0806
	(.0211)	(.0252)	(.0248)	(.0298)	(.0237)	(-.0258)	(.0304)	(.0292)	(.0480)	(.0321)
Annual Hours (ln)	.2315	.1057	.2802	.3262	.1801	.6102	.2467	-.1463	.1648	.4835
	(.0987)	(.1088)	(.0999)	(.0888)	(.1101)	(.0961)	(.1313)	(.1301)	(.1319)	(.1224)
Annual Weeks (ln)	.0750	-.5368	-.1726	-1.0516	.1124	.4137	-.6699	2.0899	-1.9277	-1.0743
	(.5550)	(.6206)	(.5263)	(.4998)	(.5806)	(.4892)	(.6547)	(.5865)	(.6804)	(.6241)
Age at M.D	-.0148	-.0066	.0091	-.0187	.0068	-.0076	-.0101	.0271	-.0203	-.0301
	(.0078)	(.0117)	(.0098)	(.0097)	(.0098)	(.0080)	(.0118)	(.0143)	(.0157)	(.0128)
Solo Practice	-.1069	-.1823	-.2322	-.1822	-.1118	-.1442	-.0116	-.3344	-.1268	-.0734
	(.0574)	(.0533)	(.0596)	(.0539)	(.0494)	(.0814)	(.0822)	(.0599)	(.0670)	(.0705)
Incorporated	.1991	.1292	2103	.0721	.1548	.1400	.2423	.0451	.0379	.0599
	(.0578)	(.0524)	(.0538)	(.0519)	(.0506)	(.0524)	(.0703)	(.0625)	(.0716)	(.0659)
GT Average Hours	.1099	.0565	-.0664	-.1824	-.1018	.0662	.0186	.2051	.0724	-.0232
	(.0760)	(.0923)	(.0803)	(.0856)	(.0693)	(.0787)	(.1585)	(.1035)	(.0971)	(.1149)
LT Average Hours	.0465	-.1154	-.0333	.0032	.0264	.1064	-.0071	.0925	-.1013	.1582
	(.0698)	(.0593)	(.0726)	(.0622)	(0606)	(.0603)	(.0930)	(.0782)	(.0803)	(.0813)
Board Certification	-.0233	.1013	.0583	.1290	.1178	.0419	.1575	.0792	.1928	.0465
	(.0762)	(.0536)	(.0537)	(.0568)	(.0546)	(.0503)	(.0677)	(.0643)	(.0751)	(.0732)
Intercept	8.7768	12.0691	8.9266	12.7711	8.3994	4.3774	11.5587	2.8257	17.9852	11.8741
	(2.1199)	(2.2319)	(2.0352)	(1.888)	(2.1394)	(1.9122)	(2.5301)	(2.3457)	(2.7623)	(2.4086)
R^2	.207	.168	.292	.245	.186	.227	0.215	0.229	0.187	0.249

Net income from practice (1n)
(standard errors in parentheses)

Age at receipt of the MD, contrary to expectations, is statistically significant (negatively) only for ophthalmology/otolaryngology. Also, board certification is significantly positive only for obstetrics/gynecology, pediatrics, allergy/dermatology and neurological/orthopedic surgery.

Surprisingly, reporting greater than average hours in the survey week is negatively significant only for obstetrics/gynecology, while reporting less than average hours is never significantly positive.

Although a functional form implying a constant elasticity of earnings with respect to hours has been estimated, because the estimated elasticity is less than unity the marginal wage rate will decline and will be less than the average wage rate. This is indicated in Table 3.8, which presents the estimated marginal wage rate at five hypothetical levels of annual hours and at ages 30 to 75, assuming a three year period of graduate medical training. Since the PPCI explicitly excludes trainees, the estimates cannot be extrapolated back to the date of degree receipt, as was done in the case of the CPS estimates. These estimates also assume an unincorporated group practice and medical school graduation at age 26.

Marginal wage rates decline markedly with increases in hours, falling in most specialties by more than one-third when annual hours increase from 1,600 to 3,000. With the exception of neurological and orthopedic surgery, for which a continuous decline is observed, marginal wage rates first rise and then decline with age.

Table 3.9 parallels the preceding table, identifying earnings as a function of annual hours and age. Because of the low and declining marginal wage rate, earnings increase very little with increases in hours. For example, even in psychiatry, with the highest elasticity of earnings with respect to hours, a 20 percent increase in hours (from 2,000 to 2,400) results in only a 12 percent increase in earnings.

TABLE 3.8

Marginal Physician Hourly Earnings—1976 by Specialty, Age, and Annual Hours

	Annual Hours				
General/Family Practice	1,600	2,000	2,400	2,800	3,000
Age					
30	$5.28	$4.45	$3.87	$3.44	$3.26
35	5.88	4.96	4.31	3.83	3.63
40	6.31	5.31	4.62	4.10	3.89
45	6.51	5.48	4.77	4.23	4.02
50	6.46	5.45	4.73	4.20	3.99
55	6.18	5.20	4.52	4.02	3.81
60	5.68	4.79	4.16	3.70	3.51
65	5.03	4.24	3.68	3.27	3.10
70	4.29	3.61	3.14	2.79	2.64
General Surgery					
Age					
30	$2.93	$2.40	$2.04	$1.78	$1.67
35	3.26	2.67	2.27	1.97	1.86
40	3.53	2.89	2.45	2.14	2.01
45	3.72	3.05	2.59	2.25	2.12
50	3.82	3.13	2.66	2.32	2.18
55	3.83	3.14	2.66	2.32	2.18
60	3.74	3.06	2.60	2.26	2.13
65	3.55	2.91	2.47	2.15	2.02
70	3.29	2.70	2.29	1.99	1.88
Internal Medicine					
Age					
30	$7.57	$6.45	$5.66	$5.06	$4.82
35	8.40	7.15	6.27	5.61	5.34
40	8.95	7.62	6.68	5.98	5.69
45	9.17	7.81	6.85	6.13	5.83
50	9.03	7.69	6.74	6.03	5.74
55	8.54	7.28	6.38	5.71	5.43
60	7.77	6.62	5.80	5.19	4.94
65	6.79	5.79	5.07	4.54	4.32
70	5.71	4.86	4.26	3.82	3.64
Obstetrics/Gynecology					
Age					
30	$9.32	$8.02	$7.09	$6.39	$6.10
35	10.30	8.87	7.84	7.07	6.75
40	10.93	9.40	8.32	7.50	7.16
45	11.13	9.58	8.47	7.63	7.29
50	10.88	9.36	8.28	7.46	7.12
55	10.20	8.78	7.76	7.00	6.68
60	9.19	7.91	6.99	6.30	6.02
65	7.94	6.83	6.04	5.45	5.20
70	6.59	5.67	4.81	4.33	4.14
Pediatric Surgery/Pediatrics					
Age					
30	$3.90	$3.25	$2.80	$2.47	$2.33
35	4.35	3.62	3.12	2.75	2.60
40	4.67	3.89	3.35	2.95	2.79
45	4.84	4.03	3.47	3.06	2.89
50	4.83	4.03	3.47	3.06	2.89
55	4.65	3.88	3.34	2.94	2.78
60	4.32	3.60	3.10	2.73	2.58
65	3.86	3.22	2.77	2.44	2.31
70	3.33	2.78	2.39	2.11	1.99

TABLE 3.8 (Continued)

	1,600	2,000	2,400	2,800	3,000
Child Psychiatry/Psychiatry					
Age					
30	$12.13	$11.12	$10.36	$9.75	$9.50
35	13.16	12.07	11.24	10.58	10.30
40	13.93	12.77	11.90	11.20	10.91
45	14.39	13.19	12.29	11.57	11.26
50	14.51	13.30	12.39	11.66	11.35
55	14.26	13.07	12.18	11.47	11.16
60	13.69	12.55	11.68	11.00	10.71
65	12.81	11.74	10.94	10.30	10.03
70	11.70	10.73	9.99	9.41	9.16
Allergy/Dermatology					
Age					
30	$6.22	$5.26	$4.58	$4.08	$3.87
35	6.70	5.67	4.94	4.40	4.17
40	7.01	5.93	5.17	4.60	4.37
45	7.13	6.02	5.25	4.68	4.44
50	7.03	5.94	5.18	4.61	4.38
55	6.73	5.69	4.96	4.42	4.19
60	6.26	5.29	4.61	4.10	3.90
65	5.65	4.77	4.16	3.70	3.52
70	4.95	4.18	3.65	3.25	3.08
Neurological Surgery/ Orthopedic Surgery					
Age					
30	$7.19	$5.97	$5.13	$4.51	$4.26
35	6.72	5.57	4.79	4.21	3.97
40	6.30	5.23	4.49	3.95	3.73
45	5.93	4.93	4.23	3.72	3.51
50	5.62	4.66	4.00	3.52	3.32
55	5.34	4.43	3.81	3.35	3.16
60	5.10	4.23	3.63	3.20	3.02
65	4.89	4.06	3.49	3.07	2.89
70	4.71	3.91	3.36	2.95	2.79
Ophthalmology/Otolaryngology					
Age					
30	$12.14	$10.82	$9.85	$9.10	$8.78
35	13.31	11.86	10.79	9.97	9.62
40	14.01	12.48	11.36	10.49	10.12
45	14.16	12.62	11.49	10.61	10.24
50	13.75	12.25	11.15	10.30	9.94
55	12.82	11.43	10.40	9.61	9.27
60	11.49	10.24	9.32	8.60	8.30
65	9.88	8.81	8.02	7.40	7.14
70	8.17	7.28	6.62	6.12	5.90

TABLE 3.9

Annual Physician Earnings—1976
By Specialty, Age, and Annual Hours

	Annual Hours				
General/Family Practice Age	1,600	2,000	2,400	2,800	3,000
30	$36,501	$38,437	$40,094	$41,550	$42,219
35	40,664	42,820	44,666	46,289	47,034
40	43,597	45,908	47,887	49,627	50,426
45	44,985	47,370	49,413	51,208	52,033
50	44,671	47,040	49,068	50,851	51,670
55	42,697	44,961	46,900	48,604	49,386
60	39,276	41,358	43,141	44,709	45,429
65	34,768	36,612	38,190	39,578	40,215
70	29,624	31,195	32,540	33,722	34,265
General Surgery Age					
30	$44,376	$45,435	$46,319	$47,079	$47,424
35	49,302	50,478	51,460	52,305	52,688
40	53,373	54,647	55,710	56,625	57,039
45	56,300	57,643	58,765	59,730	60,167
50	57,866	59,247	60,399	61,391	61,840
55	57,951	59,334	60,488	61,482	61,931
60	56,551	57,900	59,027	59,996	60,435
65	53,769	55,052	56,123	57,045	57,462
70	49,818	51,006	51,999	52,853	52,239
Internal Medicine Age					
30	$43,241	$46,031	$48,444	$50,582	$51,570
35	47,947	51,041	53,079	56,087	57,182
40	51,101	54,399	57,250	59,777	60,943
45	52,351	55,728	58,649	61,238	62,433
50	51,545	54,871	57,747	60,296	61,473
55	48,782	51,929	54,651	57,064	58,177
60	44,375	47,238	49,714	51,908	52,922
65	38,798	41,302	43,466	45,385	46,271
70	32,604	34,707	36,526	38,139	38,883
Obstetrics/Gynecology Age					
30	$45,727	$49,180	$52,193	$54,885	$56,134
35	50,535	54,351	57,682	60,657	62,037
40	53,607	57,665	61,188	64,344	65,809
45	54,584	58,706	62,304	65,517	67,008
50	53,348	57,376	60,892	64,032	65,490
55	50,045	53,824	57,123	60,068	61,436
60	45,068	48,471	51,441	54,094	55,326
65	38,949	41,890	44,457	46,750	47,814
70	32,313	34,753	36,882	38,785	39,667
Pediatric Surgery/Pediatrics Age					
30	$34,676	$36,098	$37,304	$38,354	$38,834
35	38,640	40,225	41,568	42,738	43,273
40	41,512	43,214	44,657	45,915	46,489
45	42,995	44,758	46,253	47,555	48,150
50	42,931	44,692	46,184	47,484	48,078
55	41,328	43,023	44,460	45,712	46,284
60	38,357	39,930	41,264	42,426	42,956
65	34,320	35,728	36,921	37,960	38,435
70	29,604	30,818	31,847	32,744	33,153

TABLE 3.9 (Continued)

	Annual Hours				
	1,600	2,000	2,400	2,800	3,000
Child Psychiatry/Psychiatry					
Age					
30	$31,809	$36,449	$40,739	$44,757	$46,681
35	34,514	39,548	44,202	48,562	50,650
40	36,535	41,864	46,791	51,406	53,616
45	37,733	43,237	48,326	53,092	55,375
50	38,034	43,582	48,711	53,516	56,817
55	37,395	42,850	47,892	52,616	54,878
60	35,883	41,118	45,957	50,489	52,660
65	33,585	38,484	43,013	47,255	49,287
70	30,680	35,155	39,292	43,168	45,024
Allergy/Dermatology					
Age					
30	$40,321	$42,604	$44,564	$46,292	$47,087
35	43,464	45,925	48,038	49,900	50,757
40	45,484	48,058	50,270	52,219	63,115
45	46,210	48,825	51,072	53,052	53,963
50	45,577	48,157	50,373	52,326	53,225
55	43,644	46,114	48,236	50,107	50,967
60	40,568	42,864	44,837	46,575	47,375
65	36,613	38,685	40,465	42,034	42,756
70	32,077	33,892	35,082	36,826	37,459
Neurological Surgery/ Orthopedic Surgery					
Age					
30	$69,830	$72,446	$74,657	$76,578	$77,454
35	65,199	67,642	69,705	71,499	72,317
40	61,151	63,442	65,378	67,060	67,827
45	57,612	59,770	61,594	63,179	63,901
50	54,524	56,567	58,292	59,792	60,476
55	51,837	53,779	55,419	56,845	57,496
60	49,502	51,356	52,923	54,285	54,906
65	47,489	49,269	50,772	52,078	52,674
70	45,762	47,477	48,925	50,184	50,758
Ophthalmology/Otolaryngology					
Age					
30	$40,188	$44,767	$48,892	$52,675	$54,462
35	44,040	49,057	53,578	57,724	59,681
40	46,360	51,642	56,400	60,764	62,826
45	46,868	52,207	57,018	61,430	63,513
50	45,502	50,686	55,356	59,640	61,662
55	42,440	47,275	51,632	55,627	57,514
60	38,013	42,344	46,246	49,824	51,514
65	32,707	36,433	39,790	42,869	44,323
70	27,028	30,107	32,882	35,426	36,627

As in the case of the CPS occupations, it is possible to decompose predicted earnings over the life cycle into components attributable to changes in (a) marginal wage rates and (b) annual hours. This decomposition is summarized, by specialty, in Table 3.10. With the exception of neurological and orthopedic surgery, for which earnings decline continuously with age and experience, earnings peak between the ages of 44 and 52.

Marginal wage rates rise in all cases from age 30 to age of peak earnings, on average by about 25 percent. However, because hours decline over the same period (except in general surgery), the relative increase in earnings is less than the proportionate increase in the marginal wage rate. From the age of peak earnings to age 65 the marginal wage rate declines in all specialties other than general surgery. Annual hours decline in all specialties over this period. Thus, earnings at age 65 are substantially less than peak earnings. If hours were constant (for example, in Table 3.10 at 2,400), earnings would generally peak slightly later, would rise more from age 30 to age of peak earnings, and would decline less from the peak to age 65.

Estimates of Returns to Physician Training and Specialization

The estimated earnings functions provide the basis for a range of alternative estimates of the returns to physician training and specialization. The principle measure of returns used here is the present value of the earnings differentials observed over the working lifetime (a) between the representative physician and the representative incumbent in any alternative occupation and (b) between the representative specialist and representative general/family practitioner.

In the CPS analysis it is assumed that prior to the completion of schooling earnings are in fact zero. Thus, the foregone earnings associated with the choice of a career requiring lengthier schooling are taken into account in the estimates. Because physician training requires schooling at least equal in duration to that associated with any other occupation, the failure to take into account any earnings prior to completion of schooling will impart a downward bias to estimated returns to physician training. Although incorporating foregone earnings, these gross estimates are unadjusted for other schooling costs, for example, tuition, fees, books, laboratory supplies. This adjustment will be incorporated below in the derivation of estimated net returns.

Returns to physician training relative to alternative occupations are evaluated at age 18, assuming entry into practice on completion of required schooling and labor force participation through age 65. In each occupation the observed modal years of schooling are assumed. Specifically, the following years of schooling, by occupation, are stipulated:

	Modal Years of Schooling
Accountants	16
Engineers	16
Lawyers and judges	19
Natural scientists	20
Physicians	20
Health technicians	14
College faculty	20
Teachers (ex college)	16
Engineering and science technicians	14
Public administrators	16
Bank officers	16
Health and education administrators	16
Miscellaneous managers and officials	14
Trade-related managers	14
Computer and math specialists	16

Because all medical specialties require completion of medical school, the HCFA-based estimates of returns to specialization need not be adjusted for schooling costs. However, the duration of graduate medical training varies substantially across specialties, while the earnings functions relate only to the period after completion of graduate training and entry into active practice. Thus, it is necessary to incorporate explicitly the period of graduate medical training, recognizing the foregone earnings costs associated with specialization. Estimates of gross returns are computed ignoring residency stipends. Net returns are then derived by treating these stipends as negative tuition charges.

Stipulated periods of graduate training for each specialty are based upon stated certification requirements of various specialty boards, with consideration for the treatment by each specialty board of the first (internship) year of training. Subspecialty training, however, has not been taken into account. The assumed durations of graduate training, by specialty, are

(1) General/Family practice	2	graduate training years
(2) General Surgery	4	graduate training years
(3) Internal medicine	3	graduate training years
(4) Obstetrics/Gynecology	4	graduate training years
(5) Pediatrics	3	graduate training years
(6) Psychiatry	4	graduate training years
(7) Allergy/Dermatology	4	graduate training years
(8) Neurological/ Orthopedic surgery	5	graduate training years
(9) Ophthalmology/ Otolaryngology	4	graduate training years

TABLE 3.10

Specialty Life Cycle Hours and Earnings Relationships

	At Estimated Actual Hours										At 2,400 Hours				
					Ratio to Peak Earnings Year Value									Ratio to Peak Earnings Year Value	
					Earnings at		Marg. Wage at		Hours at					Wage at	
	Age at Peak Earnings	Peak Earnings	Hours at Peak Earnings	Marg. Wages at Peak Earnings	30	65	30	65	30	65	Age at Peak Earnings	Peak Earnings	Peak Wages	30	65
Gen/Fam Prac	46	$52,000	2,971	$4.05	.84	.75	.71	.84	1.18	.90	47	$49,503	$4.78	.81	.77
Gen Surg	52	62,154	3,039	2.16	.76	.92	.81	1.01	.95	.91	53	60,640	2.67	.76	.93
Int Med	45	62,322	2,981	5.86	.83	.72	.83	.80	1.0	.91	46	58,656	6.85	.83	.74
Obs/Gyn	45	65,964	2,859	7.53	.85	.70	.81	.75	1.05	.94	45	62,304	8.47	.84	.71
Ped Surg/Peds	47	47,938	2,866	3.01	.81	.78	.76	.86	1.08	.91	47	46,430	3.48	.80	.80
Ch Psy/Psy	49	50,356	2,533	12.13	.83	.82	.84	.93	1.0	.88	49	48,726	12.39	.84	.88
All/Derm	45	50,609	2,313	5.40	.88	.78	.85	.83	1.04	.94	45	51,072	5.25	.87	.79
Neuro/Ortho Surg	30	75,215	2,511	4.94	1.0	.70	1.0	.74	1.0	.91	30	74,657	5.13	1.0	.68
Oph/Otol	44	59,886	2,651	10.92	.80	.61	.93	.80	.86	.77	44	57,074	11.50	.86	.70

Thus, the indicated first year of practice, assuming medical school graduation at age 26, would occur at age 29 for general/family practice, at age 30 for internal medicine and pediatrics, at age 31 for general surgery, obstetrics and gynecology, psychiatry, allergy and dermatology, and ophthalmology, and at age 32 for neurological and orthopedic surgery.

Two alternative sets of estimated returns are derived. The first ignores inter-occupational and inter-specialty differences in age-specific mortality rates, using white male age-specific mortality rates in the CPS analysis and male physician age-specific mortality in the HCFA analysis. The second set then recognizes inter-occupational and inter-specialty differences in mortality experience, scaling the basic age-specific mortality rates by occupational- and specialty-specific standard mortality ratios (SMRs), equal to (100 times) the age-specific mortality rate for the profession or specialty relative to the age specific mortality rate for the population of which it is a part.

In the CPS analysis, weighted-average SMRs (weighted by the age distribution of each profession's incumbents) for the 20 to 64 year-old population are derived.[6] For the professions considered here, these standard mortality ratios are:

	SMR
Accountants	94
Engineers	73
Lawyers and judges	90
Natural scientists	56
Physicians	91
Health technicians	109
College faculty	52
Teachers (ex college)	61
Engineering and science technicians	73
Public administrators	68
Bank officers	81
Health and education administrators	68
Miscellaneous managers and officials	86
Trade-related managers	98
Computer and math specialists	56

[6]These standard mortality ratios are taken from United States Department of Health, Education, and Welfare, Public Health Service, National Vital Statistics Division. *Vital Statistics-Special Reports.* Mortality by occupation and cause of death among men 20 to 64 years of age: United States, 1950. 53(3): 137-170, Washington, D.C.: Government Printing Office, 1963. The standard mortality ratio for engineers used is a weighted average of the SMRs for all subcategories of engineers. The weighting factor used is (SMR/Actual Deaths)$^{-1}$, which is proportional to the population in subcategory i.

It should be noted that these SMRs are derived from 1950 census data, and therefore may reflect mortality experiences quite different from those faced by incumbents in these occupations in 1977. Of the occupations considered, this difference is likely to be most substantial in the case of health technicians as a result of the institution of numerous safety precautions subsequent to 1950.

The age-specific mortality rates for the general population were taken from United States Department of Commerce, Bureau of the Census. *Statistical Abstracts of the United States.* 98th Annual Edition, Washington, D.C.: Government Printing Office, (1977).

In the HCFA specialty analysis, adjustments for mortality are based on estimated age-specific mortality rates of male physicians, modified by standard mortality ratios for each specialty.[7] The age-specific physician mortality rates (per 1,000 persons in the specified age group) used here are

Ages 27 to 34	0.7 per 1,000
Ages 35 to 39	1.4 per 1,000
Ages 40 to 44	2.2 per 1,000
Ages 45 to 49	4.3 per 1,000
Ages 50 to 54	6.6 per 1,000
Ages 55 to 59	11.1 per 1,000
Ages 60 to 64	18.7 per 1,000
Ages 65 to 69	29.4 per 1,000
Ages 70 to 71	46.4 per 1,000

Standard mortality ratios, by specialty, are

	SMR
(1) General/family practice	1.143
(2) General surgery	0.891
(3) Internal medicine	0.834
(4) Obstetrics/gynecology	0.853
(5) Pediatrics	0.725
(6) Psychiatry	0.960
(7) Allergy/dermatology	0.890
(8) Neurological/orthopedic surgery	0.807
(9) Ophthalmology/otolaryngology	0.799

[7]Goodman, Louis J., *Milband Memorial Fund Quarterly.* The Longevity and Mortality of American Physicians, 1969-1973. 53(3): 353-375. Summer 1975.

Associative comparisons of the mortality-adjusted returns estimated in the two analyses done in this study (CPS professionals to physicians: general practitioners to medical specialists) are valid only if one assumes that the 1950 Census Bureau and 1969-73 Goodman mortality ratios for physicians are identical. This is approximately correct for the physician population as a whole (SMR_{1950} = 91, $SMR_{1969-73}$ = 96). However, for the male physician population, the 1969-73 SMR is 74.7, implying that associative comparisons should not be made.

Apart from the observation that higher than average mortality of general practitioners (greater by 14 percent than that of all physicians) is offset by lower than average mortality of the specialties considered here (generally 10 to 20 percent less than average), these specialty-specific differences require little comment, although the remarkably lower than average mortality experience of pediatricians might be noted. Also, the variation in mortality across medical specialties is substantially lower than that observed across the professional occupations identified in the CPS analysis.

As discussed in detail above, the critical issue in the derivation of estimated returns to schooling and occupational choice involves the appropriate treatment of hours-of-work differentials. Ideally, one would determine the hours which the representative utility-maximizing physician or medical specialist would choose to work in any alternative occupation or specialty and utilize the earnings associated with this hypothetical level of hours in determining the returns to the choice of medicine over the alternative occupation. An exploratory variant of this approach is in fact utilized in another paper which assesses returns to alternative medical specialty choices. Because of the greater complexity of that approach and the small effects obtained, the present analysis employs a more conventional approach.

The alternative estimates of the gross capital values of returns to physician training and specialization utilized here are:

V_{ij}^{U}: the present value of differential earnings in i over j unadjusted for hours of work difference;

V_{ij}^{ANP} and V_{ij}^{ANL}: hours of work-adjusted estimates appropriately recognizing the nonlinearity of the hours-earnings relationship and utilizing a Paasche adjustment to hours in i and Laspeyre adjustment to hours in j, respectively; and

V_{ij}^{ALP} and V_{ij}^{ALL}: hours of work-adjusted estimates inappropriately assuming linearity of the hours-earnings relationships, again incorporating Paasche and Laspeyre adjustments, respectively.

These estimates are derived in all cases by discounting at an "income rate of interest" of 5 percent. Because the income rate of interest is equal to the real rate of interest less the rate of secular real income growth, that is, the rate at which the earnings profiles are shifting upward over time, the assumption of a 5 percent income rate of interest seems conservatively high when it is considered that the real interest rate (the nominal rate less the rate of inflation) historically has been less than 3 percent, usually less than 1.5 percent, and frequently even less than 1 percent.

Table 4.1 presents the alternative gross capital value estimates, comparing physicians (occupation i) to each of the alternative CPS occupations (occupation j), assuming a 5 percent discount rate and ignoring occupational differences in mortality. Adjustment for occupational specific mortality is incorporated in Table 4.2.

TABLE 4.1

Alternative Estimates of the Gross Capital Values of the Choice of a Medical Career

5 Perçent Discount Rate
Population Mortality Adjustment

Summary of Physician Returns

		V^{U}	V^{ANP}	V^{ANL}	V^{ALP}	V^{ALL}
1.	Accountants	147712.	103006.	129718.	61688.	57318.
2.	Engineers	147102.	108001.	129483.	63413.	58599.
3.	Lawyer/Judges	57619.	17405.	52035.	8209.	10130.
4.	Natural Sci.	229379.	217078.	215010.	188240.	153428.
5.	Physicians	0.	0.	0.	0.	0.
6.	Health Tech	247214.	183371.	227936.	185322.	156171.
7.	College Fac.	198914.	178236.	190234.	154638.	131098.
8.	Teachers	210765.	198595.	195120.	150524.	126700.
9.	Eng. and Sci Tech	192288.	149953.	169124.	100296.	87950.
10.	Public Admin.	154610.	134514.	132131.	60309.	51913.
11.	Bank Officers	138720.	108773.	124426.	58586.	58161.
12.	Health and Ed Ad	144238.	137980.	134537.	91214.	81127.
13.	Misc. Managers	148630.	135917.	138590.	82644.	84703.
14.	Trade-re Man.	160079.	132788.	149465.	90611.	93328.
15.	Comp and Math Tech	116760.	104514.	98247.	14128.	22666.

TABLE 4.2

Alternative Estimates of the Gross Capital Values of Choice of a Medical Career

5 Percent Discount Rate
Occupation Mortality Adjustment

Summary of Physician Returns

		V^U	V^{ANP}	V^{ANL}	V^{ALP}	V^{ALL}
1.	Accountants	149383.	104555.	131230.	63071.	58385.
2.	Engineers	145543.	105872.	127774.	60646.	56467.
3.	Lawyer/Judges	57922.	17520.	52265.	8149.	10081.
4.	Natural Sci.	226090.	213362.	211586.	183514.	149638.
5.	Physicians	0.	0.	0.	0.	0.
6.	Health Tech.	250518.	186934.	231053.	188878.	158812.
7.	College Faculty	194050.	172959.	185280.	148341.	125822.
8.	Teachers	209042.	196519.	193255.	147554.	124412.
9.	Eng and Sci Tech	191815.	148784.	168455.	98666.	86785.
10.	Public Admin	152328.	131589.	129660.	56258.	48951.
11.	Bank Officers	138229.	107711.	123803.	57256.	57133.
12.	Health and Ed Ad	141862.	135441.	132084.	87989.	78382.
13.	Misc Managers	149238.	136487.	139097.	82820.	84867.
14.	Trade-re Man	162415.	135092.	151693.	92886.	95195.
15.	Comp and Math Tech	111479.	98772.	92812.	6425.	16790.

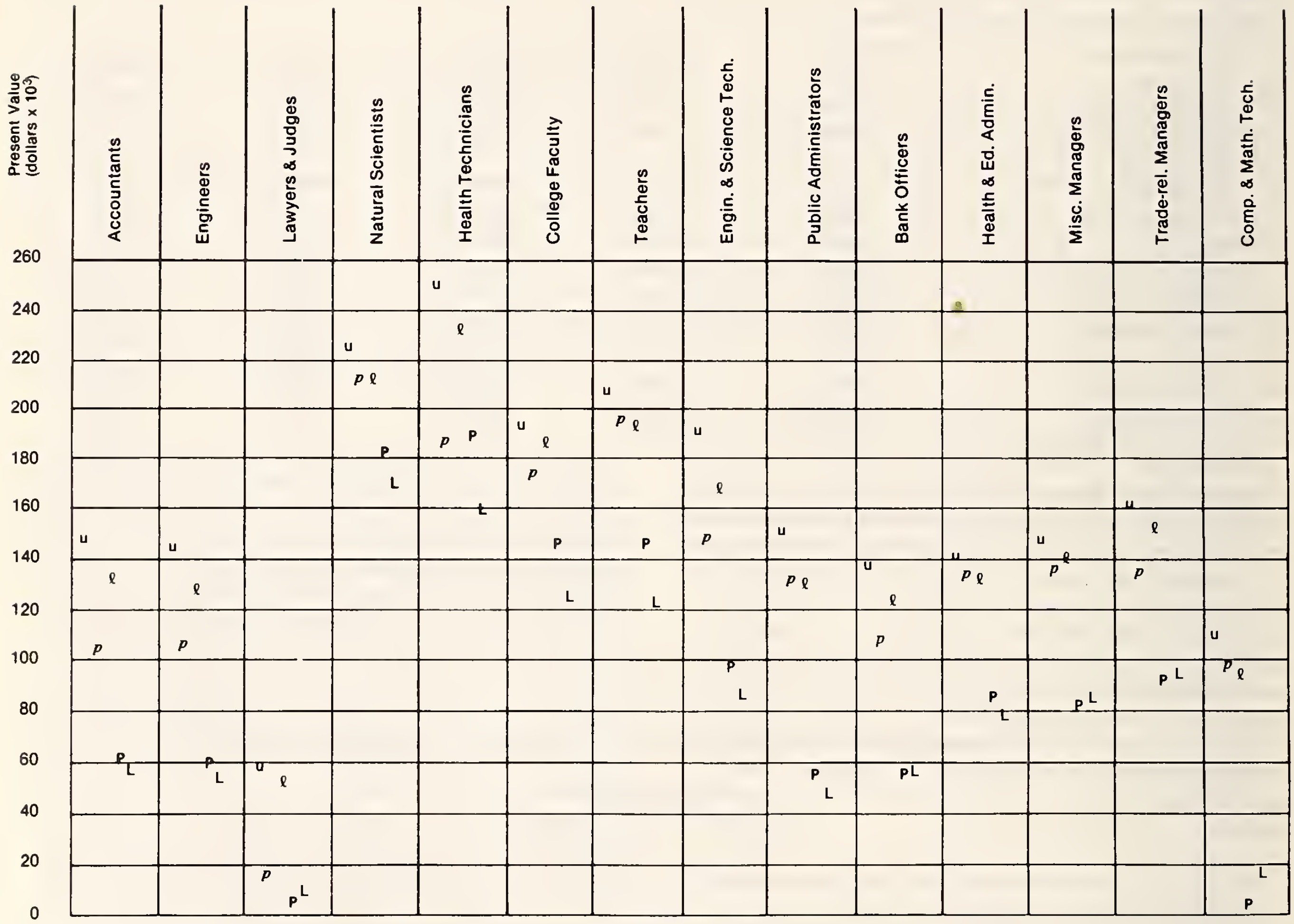
The most important conclusion from these estimates of the gross capital values of the choice of a medical career is that, regardless of the mortality adjustment, the nonlinear hours-adjusted estimates, V^{ANP} and V^{ANL}, correspond much more closely to the unadjusted estimate, V^{U}, than to the linear hours-adjusted estimates, v^{ALP} and V^{ALL}. In most cases the nonlinear hours-adjusted estimates are less than 25 percent smaller than the unadjusted estimates, as can be seen in Figure 4.1 for the occupation-specific mortality adjusted estimates. In contrast, the inappropriate linear hours-adjusted estimates, also displayed in Figure 4.1, are frequently less than one-half as great as the unadjusted estimates.

Utilizing the linear adjustment, the gross capital value of returns would unambiguously fall below $20,000 by comparison to two alternative occupations (lawyers and computer and mathematical specialists) and would be greater than $100,000 only by comparison to four alternative occupations (non-college teachers, college faculty, natural scientists, and health technicians). In contrast, the nonlinear hours adjustments suggest substantially greater returns. By comparison to lawyers, physician returns would increase from over $10,000 to over $52,000 (Laspeyre linear and nonlinear, respectively). In comparison to computer and mathematical specialists, estimates of physician returns would increase from less than $20,000 (linear) to almost $100,000 (nonlinear).

Interestingly, although the Paasche estimate of differential earnings represents an overestimate of the true differential in any year, while the opposite is the case with reference to the Laspeyre estimate, the Laspeyre estimate of the gross capital value of the differential frequently exceeds the Paasche estimate. On inspection, however, this result is quite explicable. Recall that the Laspeyre estimate is obtained by evaluating the earnings function of physicians at observed hours in the alternative occupation. Because the marginal wage rate of physicians is low, both absolutely and relative to that of most comparison occupations, this implies only a slight reduction in physician earnings. Given a higher marginal wage rate (or if lower, a marginal wage rate which is declining less rapidly), evaluating the earnings function of the alternative occupation at estimated physician hours implies a significant increase in alternative earnings in the Paasche estimate, resulting in a significant reduction in the estimated earnings differential. Also, because the excess of physician over non-physician hours declines over the life cycle, the effect of the hours adjustment in the Paasche estimate will be greater in the early years of labor force activity, which will be disproportionately reflected in the present values.

Because of delayed physician entry into the labor force and the generally more rapid growth of physician earnings with experience, physician earnings are disproportionately concentrated in the high mortality phase of the life cycle (for example, after age 55 when the age-specific mortality rate first exceeds 1 percent). Thus, by comparison to estimates ignoring mortality (not shown here), the incorporation of the population mortality adjustment reduces the gross capital values of physician training and occupational choice by between 5 and 20 percent, depending on comparison occupation and measure.

FIGURE 4.1
Alternative Adjustments of the Gross Capital Values of Choice of a Medical Career, r = .05, Occ. Mortality



Key: u - unadjusted, *p* - Paasche nonlinear adjusted, ℓ - Laspeyre nonlinear adjusted, P - Paasche linear adjusted, L - Laspeyre linear adjusted.

Introducing occupation-specific mortality has only minor consequences for estimated returns to physician training, as can be seen by comparing Table 4.1 to Table 4.2. Because the standard mortality ratio of physicians (although less than that of the population at large) exceeds that of most other professional occupations, the gross capital values usually decline marginally. Only by comparison to health technicians (SMR=109), trade-related managers (SMR=98) and accountants (SMR=94) would estimated returns rise.

Accepting these estimates, the gross returns to medical training are quite high by comparison to any of the alternative occupations considered here, with the possible exception of law. These gross capital value estimates, however, are unadjusted for differential schooling costs, which must be incorporated if net returns to a medical career are to be derived.

Because the unadjusted (V^U) and Paasche and Laspeyre linear adjusted (V^{ALP} and V^{ALL}) estimates of gross capital values are clearly inappropriate, these can be dispensed with in the derivation of the net capital values. To further simplify the analysis, a geometric mean hours adjusted estimate is utilized here as a single replacement for the Paasche and Laspeyre nonlinear hours adjusted estimate (V^{ANP} and V^{ANL}). This geometric (superscript G) nonlinear hours adjusted estimate is defined as

$$V_{ij}^{ANG} = \sum_{a=L}^{U} \left(S_{iLa} \; \overline{Y}_{Nia}(\bar{H}_{ga}) - S_{jLa} \; \overline{Y}_{Nja}(\bar{H}_{ga})\right) (1+r)^{-(a-L)}$$

where $\overline{H}_{ga} = (\overline{H}_{ia} \cdot \overline{H}_{ja})^{1/2}$ is the geometric mean of hours in occupations i and j at age a.

This nonlinear gemotric mean hours adjusted measure will generally lie between the nonlinear Paasche and Laspeyre measures.[8]

The nonlinear geometric mean hours adjusted measures of the gross capital values of returns to a medical career are presented in Table 4.3. If schooling costs were identical for all individuals, independent of occupation and year of schooling, then it would be necessary only to reduce these gross returns by the present value (at age 18) of the costs of differential years of schooling (medicine versus the alternative occupation). In fact, of course, schooling costs vary significantly across types of institutions (for example, public versus private, two-year college versus four-year college versus university) and levels of schooling (for example, graduate versus undergraduate).

To limit the number of possible estimates of differential physician schooling costs I use lower-bound estimates of schooling costs in each alternative occupation, while for medicine I estimate lower and upper bounds. For occupations for which modal schooling is 14 years, the two post-high-school years are assumed to be taken in two-year public institutions. Occupations exhibiting a mode of 16 years of schooling are assumed to involve four post-high-school years in a public four-year institution. For modes greater than 26, additional years of schooling are assumed to be taken in public universities at mean graduate tuition costs. Finally, for medicine a lower-bound estimate is based on the assumption of four undergraduate years at a public four-year institution and four years of medical school at a public university, while an upper-bound for actual costs assumes both undergraduate and medical schooling at a private university. A third, radically higher estimate is obtained by using the Institute of Medicine's (IOM) estimate of "net educational costs per student" of medical schools as a proxy for "full cost" medical school tuition. The IOM 1972-73 net cost estimate of $9,900 at private medical schools, inflated at 8 percent per year to 1975-76, gives a full cost tuition estimate of about $12,400; when medical school full cost tuition is assumed, it is also assumed that the medical student attended a four-year public college.

Since an overestimate of foregone earnings has already been taken into account with the estimation of the present value at age 18 of life-time earnings on the assumption of zero earnings while in school, the only schooling costs which should enter the calculations are tuition, required fees, and other necessary out-of-pocket schooling expenses (for example, books, laboratory fees, supplies, etc.), explicitly not including room, board, and other personal consumption expenses. Also, on the assumption that schooling costs are increasing over time at the rate at which the earnings profiles are shifting secularly, it is necessary to state these expenses in 1976 dollars. On the conservatively high assumptions concerning tuition and fees by class of institution and level of study, incorporating annual miscellaneous educational expenses of $100 at two-year institutions, of $200 at four-year public institutions for undergraduates, of $300 at private universities for undergraduates, of $400 for non-medical graduate students, and of $600 for medical students, and rounding to the nearest $100, the following cost estimates per year of schooling are obtained:

	Schooling Expenses
Undergraduate	
Two-year public	$ 500
Four-year public	700
Four-year private	3,100
Graduate	
Non-medical	1,200
Medical public	1,700
Medical private	3,800
Medical "full-cost" tuition	13,000

[8]Because of the nonlinearity of the hours-earnings functions and of the hours-age relationships, it is not necessary that the geometric mean hours adjusted estimate lie between the nonlinear Paasche and Laspeyre estimates. However, only in the comparison to natural scientists does the geometric estimate ($214.1) exceed both the Paasche and Laspeyre estimates ($213.4 and $211.6, respectively). Conversely, in five cases the geometric mean estimate is less than both the Paasche and Laspeyre estimates (engineering and science technicians, public administrators, health and education administrators, miscellaneous managers, and computer and mathematical specialists).

TABLE 4.3

Gross and Net Returns to Physician Training Recognizing Nonlinearity of Hours-Earnings Relationship

			Net Capital Values of Physician Training		
	V^{ANG}	Modal Years of Schooling	at Lower Bound Schooling Cost	at Upper Bound Schooling Cost	at "Full Cost" Medical School Tuition
1. Accountants	$113.9	16	$109.0	94.5	76.4
2. Engineers	119.6	16	114.7	100.2	82.1
3. Lawyers and Judges	28.0	19	25.8	11.3	-6.8
4. Natural Scientists	214.1	20	212.7	198.2	180.1
5. Physicians	0	20	0	0	0
6. Health Technicians	214.5	14	208.1	193.5	175.4
7. College Faculty	180.2	20	178.7	164.2	146.1
8. Other Teachers	193.4	16	188.5	173.9	155.8
9. Eng. and Science Technicians	146.5	14	140.0	125.5	107.4
10. Public Administrators	111.7	16	106.8	92.3	74.2
11. Bank Officers	118.9	16	114.0	99.5	81.4
12. Health and Ed. Administrators	130.3	16	125.3	110.8	92.7
13. Misc. Managers	133.0	14	126.5	112.0	93.9
14. Trade-related Managers	137.5	14	131.1	116.5	98.5
15. Computer and Math Specialists	80.9	16	76.0	61.4	43.3

The present values at age 18 (discounting at 5 percent) of the assumed schooling phases are

(1) Two undergraduate years at a public two-year institution	$930
(2) Four undergraduate years at a public four-year institution	2,480
(3) Four undergraduate years at a private four-year institution	10,370
(4) Three non-medical graduate years at a public university	2,690
(5) Four non-medical graduate years at a public university	3,500
(6) Four years of medical school at a public institution	4,960
(7) Four years of medical school at a private institution	11,080
(8) Four years of medical school at "full cost" tuition	37,920

Total post-high-school costs of schooling, by occupation, are then

Occupations with 14 years of schooling	(1) above	$930
Occupations with 16 years of schooling	(2) above	2,480
Occupations with 19 years of schooling	(2) + (4)	5,170
Occupations with 20 years of schooling	(2) + (5)	5,980
Medicine lower bound	(2) + (6)	7,440
Medicine upper bound	(3) + (7)	21,450
Medicine "full cost" tuition	(2) + (8)	40,400

Net capital values of the choice of medicine over alternative occupations are indicated in Table 4.3. Using the lower-bound estimate of medical schooling costs, the net returns to medicine are in excess of $100,000 by comparison to all alternatives other than law and computer and mathematical specialties, for which net values of $26,000 and $76,000, respectively, are observed. Even with the upper bound estimate of actual 1976 costs the returns to medicine are unambiguously postitive, although returns relative to law fall to less than $12,000. More remarkable still, even with "full cost" medical school tuition, net returns would exceed $70,000 in all occupations other than law and computer mathematical specialties, and would be relative ($-7,200) only by comparison to law.

The importance of recognizing the nonlinearity of the

hours-earnings relationship is indicated by Table 4.4, which replicates Table 4.3 but inappropriately assumes linearity of the hours-earnings relationship. The measure of gross capital values here is a linear geometric mean-hours adjusted estimate, defined as

$$V_i^{ALG} = \sum_{a=L}^{U} \left(S_{iLa} \, \overline{Y}_{Nia} \, \frac{(\overline{H}_{ia} \cdot \overline{H}_{ja})^{1/2}}{\overline{H}_{ia}} - S_{jLa} \, \overline{Y}_{Nja} \, \frac{(\overline{H}_{ia} \cdot \overline{H}_{ja})^{1/2}}{\overline{H}_{ja}} \right) (1+r)^{-(a-L)}$$

which again will generally lie between the linear Paasche and Laspeyre estimates.

Even on the lower bound medical school cost assumptions, the assumption of hours-earnings linearity results in net return estimates of less than $10,000 in 10 of the 14 comparisons and of less than $50,000 in three comparisons. At the upper bound estimate of actual medical school costs net returns would be less than $50,000 in six cases and negative in two. Finally, with full-cost medical school tuition, net returns would fall below $50,000, in comparison to eight alternative occupations, while net capital losses of more than $25,000 would be indicated by comparison to law and computer-mathematical specialties.

Returning to the more appropriate nonlinear hours adjusted estimates of net capital values of choice of a medical career, as presented in Table 4.3, returns to medicine are unambiguously positive by comparison to all occupations at prevailing schooling costs, especially when it is considered that schooling costs for alternative occupations represent lower-bound estimates. Even if a move should be made toward an approximately "full cost" tuition policy (with a continuation of subsidies to all other schooling), medicine would be highly profitable by comparison to all occupations other than law, and even by comparison to law, it would represent a virtual "break even" option. Only if returns are incorrectly adjusted for hours of work differentials can it be argued that the economic returns to medicine would be seriously eroded as a result of radical reductions in subsidies to medical schooling.

Gross capital values of returns to physician specialization are presented in Tables 4.5 and 4.6, which assume physician and specialty mortality, respectively. Recognition of specialty-specific mortality increases the estimates in all cases, and with the exception of internal medicine, gross returns to specialization are even higher when specialty-specific mortality is incorporated than when mortality is ignored. This finding reflects the significantly higher relative mortality experience of general practitioners. Because the alternative mortality adjustments lead to very similar conclusions, discussion hereafter is limited to the gross capital value estimates of returns to specialty choice on the last assumption of specialty-specific mortality.

On an hours-unadjusted basis, gross returns are positive and substantial only for four specialties (general surgery, internal medicine, obstetrics and gynecology, and neurological and orthopedic surgery). Ophthalmology and otolaryngology represent a (gross) break-even proposition, while losses in excess of $70,000 are estimated for pediatrics, psychiatry, and allergy and dermatology.

TABLE 4.4

Gross and Net Returns to Physician Training Inappropriately Assuming Linear Hours-Earnings Relationship

		Net Capital Values of Physician Training		
	V^{ALG}	at Lower Bound Schooling Cost	at Upper Bound Schooling Cost	at "Full Cost" Medical School Tuition
1. Accountants	$61.2	56.3	41.7	23.7
2. Engineers	59.0	54.1	39.5	21.5
3. Lawyers and Judges	9.2	7.0	-7.5	-25.6
4. Natural Scientists	165.6	164.2	149.7	131.6
5. Physicians	0	0	0	0
6. Health Technicians	173.9	167.4	152.9	134.8
7. College Faculty	136.5	135.1	120.6	102.5
8. Other Teachers	135.7	130.8	116.3	98.2
9. Eng. and Science Technicians	93.4	86.9	72.4	54.3
10. Public Administrators	52.8	47.9	33.3	15.3
11. Bank Officers	57.9	53.0	38.4	20.4
12. Health and Ed. Administrators	83.1	78.2	63.7	45.6
13. Misc. Managers	84.8	78.3	63.8	45.7
14. Trade-related Managers	95.2	88.7	74.2	56.1
15. Computer and Math Specialists	12.7	7.8	-6.7	-24.8

TABLE 4.5

Alternate Estimates of Gross Capital Values of Returns to Specialty Choice Physician Mortality for r = .05

	V^{U}	V^{ANP}	V^{ANL}	V^{ALP}	V^{ALL}
General/Family Practice	0.0	-0.0	0.0	0.0	0.0
General Surgery	39.5	46.4	41.1	67.2	56.2
Internal Medicine	92.3	100.1	101.5	124.5	126.3
Obstetrics/Gynecology	97.4	109.6	114.8	148.0	152.3
Pediatrics/Pediatric Surgery	-94.6	-83.9	-87.8	-49.6	-55.3
Child Psychiatry/Psychiatry	-94.2	-58.3	-9.5	47.7	50.9
Allergy/Dermatology	-79.9	-33.7	-34.8	99.1	124.0
Neur. Surgery/Orth. Surgery	97.5	115.0	107.5	166.7	162.4
Ophthalmology/Otolaryngology	1.5	38.6	76.6	146.3	167.0

TABLE 4.6

Alternate Estimates of Gross Capital Values of Returns to Specialty Choice Specialty Mortality for r = .05

	V^{U}	V^{ANP}	V^{ANL}	V^{ALP}	V^{ALL}
General/Family Practice	0.0	- 0.0	0.0	0.0	0.0
General Surgery	48.3	55.3	49.9	76.1	64.9
Internal Medicine	102.7	110.5	111.8	134.9	136.6
Obstetrics/Gynecology	107.3	119.5	124.7	157.8	162.2
Pediatrics/Pediatric Surgery	-82.2	-71.4	-75.3	-37.3	-42.6
Child Psychiatry/Psychiatry	-88.7	-52.9	-3.8	52.6	56.7
Allergy/Dermatology	-72.2	-26.2	-26.9	105.9	132.6
Neuro. Surgery/Orth. Surgery	109.3	126.8	119.5	178.2	175.1
Ophthalmology/Otolaryngology	12.2	49.2	88.0	156.2	179.2

Contrary to the findings of the CPS analysis, in which introduction of an hours adjustment reduced the gross capital values of returns to physician training, the hours adjusted estimates of returns to physician specialization are in all cases higher, often substantially higher, than the hours-unadjusted estimates. Focusing on those estimates appropriately recognizing the nonlinearity of the hours-earnings relationship, the Paasche and Laspeyre estimates (V^{ANP} and V^{ANL}) of the returns to ophthalmology/otolaryngology are $49,000 and $88,000, respectively, compared to an unadjusted estimate (V^{U}) of $12,000, while for psychiatry the Paasche and Laspeyre estimates of $-53,000 and $-4,000 compare to an unadjusted estimate of $-89,000. Even with the nonlinear hours adjustments, however, losses are still indicated for pediatrics, psychiatry, and allergy/dermatology.

The comparison of the nonlinear hours-adjusted measures again results in findings quite different from those observed in the CPS estimation of returns to physician training. In the latter case, the linear hours-adjusted measures resulted in severely downward biased estimates of returns to physician training. In contrast, the inappropriate linear adjustments would greatly overstate the returns to specialty training. Thus, while the two nonlinear adjusted estimates of returns to specialization in allergy/dermatology indicated losses of about $26,000, the linear adjusted estimates would indicate positive returns of between $106,000 and $133,000. Similarly, while the nonlinear estimates unambiguously indicate losses to psychiatry (of $-71,000 and $-75,000), the linear estimates would incorrectly suggest unambiguously positive returns in excess of $50,000. Only pediatrics would still appear as a negative return specialty if inappropriate linear hours adjustments were used.

If residency is considered an extension of the schooling period (and implicitly, if no net utility or disutility is associated with either preresidency or residency "schooling"), then it is appropriate to consider the residency stipend as a (negative) tuition charge and to adjust the gross capital values of returns in a manner identical to the derivation of the CPS estimates of net capital values adjusted for schooling costs. Note that the residency stipend can be considered a negative tuition charge because the gross capital value estimates discount earnings of the year of medical school graduation (assumed to occur at age 26), with the stipulation of zero "practice earnings" for the period prior to completion of the residency and entry into active practice.

Data concerning residency stipends by specialty are available only for first year residents. Thus, it is necessary to make some adjustment for increases in stipends with increased experience. Because of informal evidence of significant increments in stipends with experience, it is assumed here that stipends cross-sectionally increase 10 percent for each additional year of experience. Thus, the present value at medical school graduation of stipends over the specialty i residency period is

$$V^{S_i} = \sum_{a=1}^{L_i'} S_{i1} \quad (1+g)^{a-1} \quad (1+r)^{-a}$$

$$\simeq \sum_{a=1}^{L_i'} S_{i1}(1+g)^{-1} \quad (1+r-g)^{-a}$$

where g is the rate of increase in the stipend with experience, and

L_i is the length of residency in specialty i.

These estimates of the present values of residency stipends in 1975-76 are indicated in the first column of Table 4.7, assuming g=0.1 and r=0.05. The second column then provides the excess of the present values of residency stipends in specialty i over the stipend present value for general practice.

To limit the number of alternative net capital value estimates, the nonlinear Paasche and Laspeyre hours-adjusted measures are replaced by a single nonlinear hours adjustment based on the geometric mean of hours in the subject specialty and general practice, denoted V^{ANG}. Although the linear hours-adjusted measures have been demonstrated to contain a serious upward bias, for comparison purposes I use a linear geometric mean hours-adjusted measure in the computation of a second alternative measure of net returns.

These gross capital value estimates of returns to physician specialization, and the corresponding net capital value estimates, are indicated in Table 4.7. In general, the net capital value estimates confirm the conclusions reached on the basis of the gross capital values. Only in the cases of allergy/dermatology and psychiatry are small gross losses converted into trivial net gains when attention is focused on the estimates corrrectly recognizing hours-earnings nonlinearity. Neurological and orthopedic surgery is clearly in a class by itself with a net capital value in excess of $160,000. Internal medicine and obstetrics and gynecology, with net capital values of returns to specialization in excess of $120,000 and $140,000, are also quite profitable. General surgery and ophthalmology and otolaryngology constitute a third class, with net capital values of returns in excess of $75,000. Finally, for pediatrics a substantial loss (of greater than $60,000) is observed.

Again, the importance of recognizing hours-earnings nonlinearity is revealed. However, while the assumption of linearity would have led to downward biased estimates of net returns to physician training, it would have greatly overstated returns to physician specialization.

TABLE 4.7

	Present Value of Residency Stipends		Gross Capital Values of Returns to Specialization		Net Capital Values of Returns to Specialization Utilizing Gross Measure	
	Total	Excess Over General/ Family Pract.	V^{ANG}	V^{ALG}	V^{ANG}	V^{ALG}
General/Family Practice	$21.4	$ 0	$ 0	$ 0	$ 0	$ 0
General Surgery	49.0	27.6	52.6	70.8	79.8	97.9
Internal Medicine	35.4	14.0	111.2	135.8	125.0	149.6
Obstetrics/Gynecology	47.8	26.4	122.1	160.1	148.0	186.0
Pediatrics/Pediatric Surgery	34.7	13.3	-73.3	-39.8	-60.2	-26.7
Psychiatry/Child Psychiatry	52.0	30.6	-29.5	54.8	0.5	84.9
Allergy/Dermatology	49.7	28.3	-26.6	118.6	1.2	146.3
Neurological/Orthopedic Surgery	63.5	42.1	123.2	177.4	164.5	218.6
Ophthalmology/Otolaryngology	48.2	26.8	67.8	167.7	94.1	194.0

Conclusion

By comparison to alternative occupations, physician training has been found to be an extremely profitable investment when the nonlinearity of the hours-earnings relationship in professional occupations is recognized. In addition to compensating the physician for his or her differential work effort and covering normal interest on his/her investment (foregone earnings plus tuition, fees and other out-of-pocket schooling expenses), lifetime earnings are found to contain a substantial element of pure economic profit (for example, monopoly rent), as demonstrated in Table 4.3.

To summarize that conclusion and to indicate in more intuitively comprehensible terms the magnitudes of these profits (heretofore expressed as present values at age 18), it is useful to consider the lifetime annuities which these economic profits could purchase. Assume that the physician earns in each year what an incumbent in the alternative occupation would earn and incurs only those schooling costs observed in the comparison occupation. The net present value of the differentially higher earnings which the physician would otherwise receive (evaluated at age 18) is used to purchase an annuity which will pay the physician (or his/her survivors) an equal amount in each of 47 years (from age 19 to age 65). This amount is specified, however, in 1976 "income dollars" and would increase in each year at the rate at which the cross-sectional earnings-experience functions shifted upward. Note that these annuities, and also the earnings which the physician would have received in any alternative occupation, are paid in each year after age 18, even when the physician is in school.

These annual annuities corresponding to net capital values of returns to physician training relative to alternative occupations, under the alternative medical schooling cost assumptions (lower bound actual, upper bound actual, and medical school "full cost" tuition), are indicated in Table 5.1. With the exception of law, the choice of medicine over alternative occupations is equivalent to purchasing an annuity which will pay the 18 year old over $4,000 in every year until age 65, and in many cases the annual payment would exceed $10,000. Even at "full cost" medical school tuition, and assuming a continuation of current subsidies to all other forms of schooling, the annuity would pay over $4,000 per year by comparison to all but two alternative occupations. This indicates quite graphically the extreme profitability of a medical career.

Comparable estimates of annuity equivalents are presented in Table 5.2 for the net capital values of returns to physician specialization, compared to general practice. In this case the annuities are assumed to be paid in each year for the first 45 years after medical school graduation (for example, from age 27 to age 71 for persons graduating from medical school at age 26). In addition to the annuity the specialist is paid in each year the amount which he or she would have received had he/she entered general practice instead.

Apart from pediatrics, which implies a large negative annual annuity payment (in excess of –$3,000), and psychiatry and allergy/dermatology, for which trivial annuities are implied, the differential earnings of medical specialists give rise to economic profits with substantial annuity values, ranging from $4,500 per year for each of 45 years after medical school graduation for general surgeons to $9,300 for neurological and orthopedic surgeons.

Combined with the observation of relative inelasticity of earnings with respect to hours, suggesting at least the possibility of a relatively inelastic demand for the physician's or specialist's services, finding high economic profits indicates the probable existence of substantial monopoly power in the medical sector. This conclusion is only reinforced by the estimates of net internal "income" rates of return also presented in Tables 5.1 and 5.2. While the amount which the individual physician can invest in the asset of a medical degree is limited (given prohibitions against involuntary servitude, one can purchase title only to one physician's income stream, one's own), the returns to that investment are exceptionally high relative to the returns on alternative investments.

TABLE 5.1

Annual Annuities Paid Between Ages 19 and 64 Equivalent to Net Capital Values of Physician Training and Rates of Return to Physician Training

		Annuities in 1976 Income Dollars (Internal "income" rate of return)*		
		at Lower Bound Schooling Cost	at Upper Bound Schooling Cost	at "Full Cost" Medical School Tuition
1.	Accountants	$ 6,064 (14.0%)	$ 5,256 (11.0%)	$ 4,251 (9.5%)
2.	Engineers	6,379 (13.5)	5,570 (11.0)	4,565 (9.5)
3.	Lawyers and Judges	1,434 (10.0)	626 (6.5)	-379 (4.5)
4.	Natural Scientists	11,830 (>100)	11,021 (28.0)	10,016 (23.5)
5.	Physicians	0 (0)	0 (0)	0 (0)
6.	Health Technicians	11,570 (16.5)	10,752 (14.0)	9,757 (12.5)
7.	College Faculty	9,940 (>100)	9,132 (23.5)	8,127 (19.0)
8.	Other Teachers	10,481 (19.5)	9,672 (15.5)	8,667 (13.5)
9.	Eng. and Science Technicians	7,789 (12.5)	6,980 (11.0)	5,975 (9.5)
10.	Public Administrators	5,941 (14.0)	5,133 (11.0)	4,128 (9.5)
11.	Bank Officers	6,343 (14.0)	5,534 (11.5)	4,529 (9.5)
12.	Health and Ed. Administrators	6,971 (14.5)	6,169 (11.5)	5,158 (10.0)
13.	Misc. Managers	7,037 (12.0)	6,229 (10.5)	5,224 (9.0)
14.	Trade-related Managers	7,290 (12.0)	6,482 (10.5)	5,477 (9.0)
15.	Computer and Math Specialists	4,244 (10.5)	3,416 (9.0)	2,411 (7.5)

NOTE: Estimates are based on Table 4.4 net capital values of returns to physician training and assume a 5 percent interest rate.

* Rates of return to nearest 0.5 percentage point

TABLE 5.2

Annual Annuities Paid Between The Ages of 27 and 71 Equivalent to Net Capital Values of Physician Specialization and Rates of Return to Specialization

	Annuities in 1976 Income Dollars	"Income" Rates of Return
General/Family Practice	$ 0	(0%)
General Surgery	4,487	(12.5)
Internal Medicine	7,032	(40.5)
Obstetrics/ Gynecology	8,324	(25.0)
Pediatrics/Pediatric Surgery	-3,388	(-5.0)
Psychiatry/Child Psychiatry	30	(5.0)
Allergy/Dermatology	68	(5.0)
Neurological/ Orthopedic Surgery	9,253	(26.0)
Ophthalmology/ Otolaryngology	5,294	(20.5)

Note: Estimates are based on Table 4.7 net capital values of returns to physician specialization derived from gross estimate V^{ANG} and assume a 5 percent income rate of interest.

Rates of return to nearest 0.5 percentage point

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Comments

by Jack Hadley, Ph.D., Urban Institute

Although both of these papers are quite sophisticated and primarily technical in nature, neither has direct or strong policy implications at this time. However, I do not mean that as a criticism of the two papers. Rather, I think both can make important contributions to future policy research, and I also think that HCFA should be complimented for being willing to support this kind of research. Although basic research does not generally lead to direct answers to today's questions, it does help in the future when we look at problems.

Let me start with the Boardman and Dowd paper. I think one of the things that makes this paper interesting is that it highlights one of the more fundamental schisms within health services research: what is the role of economic theory? This question is more than a case of economists versus non-economists. It also pervades most of the health services research done by economists.

Boardman and Dowd raise the economic theory issue by asserting that much of the prior research in the area of physician behavior has not been successful. Without any citations, I was unable to agree with the authors, but I think a lot of the presentations I heard yesterday, such as the works by Sloan, Pauly, and Steinwald, suggest that we do know a fair amount about physician behavior. For instance, I think we can feel fairly confident about how physicians might respond to many of the external forces with which they might be confronted.

I think the reason for the paper's assertion is that economic theory generally makes what the authors consider a very restrictive assumption, that everyone has both identical utility functions and identical objective functions. The pitfall that they fall into—I think it is at heart of the problems underlying this schism—is that the assumption of identical utility functions clearly is made for analytical simplicity. The assumption is not meant to be a description of reality—we leave that to the more adventurous souls among us—but rather, an approach to test implications about what would happen if certain factors changed.

If you really believed that everyone has identical utility functions, then HCFA would not have to spend hundreds of thousands of dollars to collect large amounts of survey data. Instead, we could ask the FBI to find us one representative physician and give that physician an office next to the one occupied by the Director of Research. The rest of us could go home. Then every time the HCFA Administrator asks what is the result of increasing Medicaid fees, the Director could just ask the physician the question, and that would be that.

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Fortunately for those of us here, we recognize that the assumption is just an analytic simplification. In fact, when we turn to empirical research, one of the reasons for the numerous variables in the estimated equations is that we have to control for such factors as physicians' characteristics, type of practice, and demographic differences. Another common technique to control for differences is to restrict the empirical analyses to narrowly define groups of physicians.

It is this area where the Boardman and Dowd paper can make a fairly important contribution. A lot of the work being done today deals only with solo, office-based practitioners. In effect, we are saying that physicians in groups might differ from solo physicians, that physicians who do extensive amounts of research or teach or are in administration are probably different from practitioners, and that we want to try and hold that constant in some way. One of the goals of Boardman and Dowd's work is to identify and better delineate criteria for classifying physicians into analytically meaningful groups.

The second source of confusion concerning the role of economic theory has to do with the importance of the R-square in an analytic study. In other words, how important is it to explain as much of the variation as exists in the data? I believe that in many cases it is not terribly important, particularly when you are dealing with individual data. Although there are many differences among individual physicians, I would argue that many of these differences are not really very important for policy purposes; that is, physicians who work hard and maximize profits, compared to physicians who do not work so hard and maximize utility, might respond in very similar ways to changes in external forces. And again I think that both theoretical and empirical research has shown this to be true. If I had to summarize what we know about physicians, based on the last eight to 10 years of work, it is that they seem to be very much like conventional economic entrepreneurs, holding aside all of the caveats that we make about utility maximization and about the agency relationship. Although all these caveats, I think, are true, the responses we observed are that if you raise prices, you are likely to see an increase in output; that if Medicaid fees increase, physicians' willingness to treat Medicaid patients will rise; that if private fees go up, physicians are less willing to treat Medicaid patients. These are good, solid findings.

At the same time, as I said earlier, I think that the paper does make a contribution. Suppose there are different classes of physicians and that parameter estimates do differ. We should note those differences and suggest ways that empirical research can incorporate them. It is in this light that the Boardman and Dowd work can further our understanding of physician behavior.

One small aside is that, although grouping can help, as they pointed out, the styles they describe are not discrete choices. There is really a continuum of styles and it could make a big difference where you draw the lines along that continuum. For example, in my own work on physicians' participation in the Medicaid program, the question of how you define a Medicaid non-participant arose. Is it someone who treats no Medicaid patients at all? If so, what about physicians who might see a very small number of Medicaid patients, perhaps on an occasional basis, either because of a medical emergency or charity, or who might have a long-standing patient who is temporarily eligible for Medicaid? Do you want to consider them participants or non-participants? As it turns out, how you draw that line could have important implications for the estimates that are generated. Since it is probably also true when estimating many other types of behavioral relationships, I think it is a useful area to pursue.

Let me turn to Dresch's paper, which I think is a *tour de force* in some ways. The findings can be characterized in two ways: one is fairly obvious, the other subtle. The obvious finding is, lo and behold, physicians earn lots of money, making it quite profitable to go to medical school. The other finding is that if you are trying to see exactly how potential physicians might change their behavior in response to changes in physicians' income, then how you account for hours worked might make a difference.

Looking at the differences in hours worked among occupations as well as among physicians' specialties has been very illuminating, but, at the same time, I wonder if Dresch has shown that adjustments to hours worked do matter. Do we really know which adjustment is the right one? The acid test here would be to take these estimates, discount the present values of earnings, and plug the present values into occupational choice equations, specialty choice equations, and location choice equations, to understand how the different approaches to computing this value affect the implications for changes in behavior. Although this paper does not directly lead to policy conclusions, I think through this kind of exercise it could make a very important contribution to other work in that area.

Let me conclude with some questions which have to do with how one goes about computing discounted present values. In addition to the hours-of-work problem which Dresch dealt with very nicely, there are three or four other areas which may involve equally difficult problems. One—and this has been a well-known problem for a long time—is how do you deal with differences in the innate ability of individuals? If there are systematic differences between physicians and other professions or among medical specialties, the purported return to a medical degree may, in fact, be a return to ability.

My second question addresses what an hour of work means in professional occupations. The standard assumption is that work is a disutility, that you have to be compensated for an hour of work. However, I think most of us would agree that we derive some psychic benefit from what we do, at least some of the time. Again, these psychic returns may not be transferable in the sense that you compensate someone in dollars for making one choice rather than another. It is not clear how you would transfer psychic returns so that one can say how to measure those things. I do not think it is possible. It is one of the fundamental problems we have to live with.

The third question deals with dynamic changes in the market for these occupations. Dresch made some assumptions about overall aggregate growth in returns, but, at the same time, those of you who are on university faculties understand how the birth rate affects income and job opportunities for teachers. There may be, in fact, unique secular changes within markets that should be considered. That may require a large crystal ball, but it is something we could try to work toward.

Finally, these estimates are probably only as good as the data that you have to work with. I think this came up in the comparison of physician data from the HCFA surveys and the Current Population Survey. To the extent that there are sampling variations and differences in sub-occupational mix across surveys—for example, there are physicians who only provide medical care or who only teach or administer—some of these estimates will be confounded.

In spite of these problems, I think work of this sort certainly should be encouraged and should continue. I look forward to seeing the results, particularly with respect to the Boardman-Dowd paper.

Comments

John C. Gaffney, Ph.D., American Medical Association

Boardman and Dowd suggest that traditional microeconomic studies of the medical care firm, particularly those based on cross-section data, suffer from specification error. The authors argue that empirical studies of physician behavior may not adequately incorporate systematic differences in the preferences of physicians. To investigate the role of preferences in physician decision-making, the authors focus on differences in practice attributes across groups of physicians.

Ignoring systematic differences in preferences across groups of physicians does not necessarily introduce specification error. The excluded preference variable could be irrelevant to the model being investigated. For example, if geographic preferences are not correlated with income/leisure preferences, systematic differences in the former are likely to be irrelevant to the estimation of a physician's labor supply function. Further, it should be noted that traditional microeconomic studies typically *do* include variables that are likely to capture the impact of systematic differences in preferences.

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The authors develop a model of the physician's choice of "practice style," a latent variable which is not observable. They hypothesize that practice style is a function of the physician's early career decisions and exogenous factors such as age, sex, and experience. To identify the practice styles, the authors use factor analysis to reduce 12 practice attributes to five styles. Implicit in the discussion is the view that differences in practice style can be systematically related to differences in physicians' preferences.

Although Boardman and Dowd provide a useful approach to investigating systematic differences in physicians' preferences, the 12 practice attributes they choose to characterize practice style raise doubts about the validity of their analysis. The attributes selected are mostly economic characteristics of the physician's medical practice which are determined, in part, by the characteristics of the market area. For example, Style ii physicians treat low-income patients and Medicaid patients. If a medical practice is located in a low-income area, Style ii is likely to develop regardless of the physician's preferences. Thus, it could be argued that if physicians all had the same preference structure, the five practice styles would develop simply because of differences in the characteristics of market areas. Ultimately, the usefulness of the information developed in this study can be determined only by employing practice style variables in empirical studies of the medical care firm.

As for the paper by Dresch, the objective is to determine the net present value of choosing one profession over another. This requires that the income streams used in the analysis be comparable. Dresch argues that the adjustments others have made to account for differences in hours of work across professions rest on several restrictive assumptions and may not, therefore, generate comparable income streams.

Dresch's approach is to estimate earnings functions for alternative professions. By substituting the same hours of work into each earnings function, he generates "comparable" income streams with which he calculates the net present value of choosing one profession over the other. Dresch finds that the relative net returns to choosing medicine are "unambiguously positive" for both an upper and lower bound estimate of medical school costs. Further, he calculates that, even with "full cost" medical school tuition, net returns to choosing a medical career would be positive relative to 13 of the 14 alternative professions.

A number of factors raise doubts about Dresch's findings. He compares the net present value of the income stream of physicians with that of 14 other professions. With the exception of "lawyers and judges," individuals in those 14 professions are unlikely to be self-employed. In principle, Dresch should deduct from the physician's income stream an amount that represents return to the physician's investment in office facilities and an amount that represents return to the risks inherent in being self-employed. Thus, Dresch's methodology does not really generate income streams that are comparable across all 15 professions.

Several statistical problems suggest that the income streams generated form the estimated "earnings functions" should be viewed with suspicion. Dresch attempts to develop reduced form models of income determination for 15 professions. But, as he admits, the model is not really a reduced form because hours of work are included as independent variables. Since the method of ordinary least squares (OLS) is used to estimate the earnings functions, parameter estimates are subject to simultaneous equation bias. Multicollinearity problems also raise questions about Dresch's parameter estimates. Further, although the "earnings functions" achieve a good fit for cross-section data, it should be noted that the functions explain more than half the variance in earnings for only two of the 15 professions.

Dresch believes his results indicate the probable existence of monopoly power in the medical sector. However, alternative explanations are also consistent with Dresch's findings. A relatively higher rate of return to medical education could also reflect short-term market disequilibrium stemming from rapidly expanding demand. The introduction of Medicaid and Medicare, expanded private insurance coverage, and rising consumer incomes have all increased the demand for medical care services in the last 15 years. In addition, the rapidly expanding supply of physicians suggests that competitive market forces do function in the medical sector. One would expect a relatively high rate of return to attract entrants into a profession. Further, it seems inconsistent to claim that monopoly power exists in the medical sector, while observation indicates that more people are rapidly entering the medical profession. We must acquire information on the rate of return to medical education over time before the question of monopoly power versus short-term market disequilibrium can be settled.

Summary Panel

Introduction

The Summary Panel brought together a practicing physician, a health economist from academia, and a policy analyst from the Office of Legislation and Policy in the Health Care Financing Administration. Frank A. Riddick, Jr., M.D., is the Medical Director of the Ochsner Clinic in New Orleans and a Clinical Professor of Medicine at the Tulane Medical School. He is also a former member of the National Commission on the Cost of Medical Care. Stanley Wallack, Ph.D., is also a former member of the National Commission on the Cost of Medical Care and is currently the Director of the University Health Policy Consortium in Massachusetts. Prior to taking that position, he worked as a senior health economist in the Congressional Budget Office and in the office of the Assistant Secretary for Planning and Evaluation in HEW (now HHS). The final member of the panel was Ira Burney, who has been a policy analyst within HHS since 1973. His special interest is in the area of physician reimbursement. He has actively participated in the development of Departmental initiatives such as the National Health Plan and various physician reimbursement reforms.

The panel faced a difficult task, given the in-depth policy discussions of each of the preceding panels. Although all of the presentations were based on the same data sets, there was a wide variety of both topics and conclusions. However, while these papers shed light on many aspects of the physician's economic environment that previously were not well perceived, they also suggested an expanded field of vision in which there were new opportunities for research. The panelists accepted this challenge by identifying specific areas of inquiry suggested by the papers at hand.

Frank A. Riddick, Jr., M.D., Medical Director, New Orleans, Louisiana

It is a pleasure to be here, and I enjoyed the opportunity to hear the papers. As a non-economist, I am afraid I am not competent to judge whether Dr. Reinhardt should have summed the squares or whether he should have squared the sums, so I will not comment on the methodology of what I have heard.

I thank the speakers for enriching my vocabulary. I do not think I have ever come across the word "monopsony" in the practice of medicine. I also thank Mark Pauly for introducing me to the term "board-certified dummy." It happens that I have met a few people to whom this term might be applicable.

Yesterday, when Gerald Weber started his talk, he suggested that perhaps it was his advice that led to the capitation grant system for rewarding medical schools. I am not sure that I would admit to that if I had been involved in it.[1]

As I heard the papers, I was impressed that they all stemmed from the data collected in the surveys done by HCFA. The question I would pose to the contractors is this: If you were to set out under ideal circumstances to answer the particular questions that were addressed in your papers, would you have used the survey data, or would you have wanted some other source of data? And if the survey were to be the source of the data for other similar studies, in what way should further data be collected and arranged?

I am not going to attempt to review each of the papers, but I would like to tell you some of my perceptions. A paper that stimulated a good deal of discussion yesterday was Jerry Weber's, in which he looked forward to a sea of physicians in the United States. Very provocatively, he estimated the future volume of services that will be delivered by this large number of physicians by taking the rates of physician-patient encounters observed with the current complement of physicians and multiplying them by his projected number of physicians. I think the trend is unlikely to follow his predicted course, as most of the discussants acknowledged. It is clear, however, that costs are going to go up as a result of the increase in physicians, even though I do not think it will be as simple as saying, "Well, we will have x number of doctors; therefore, we will have a proportionate increase in physician-patient encounters and a proportionate increase in cost."

I think it is fair to say, and I think there is some evidence for this at present, that the increased number of physicians in the United States is making physicians available in previously underserved areas. Although the increase probably has not significantly affected the urban underserved areas of the country, physicians are beginning to locate in other areas where they perceive their services will be demanded. Some examples of this are the increase in rural underserved areas, in places like the armed forces that traditionally have difficulty in securing physicians, in some HMOs that have had trouble in hiring physicians, and in certain specialties such as geriatrics and adolescent medicine.

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[1]Gerald Weber presented a preliminary report, not included in these proceedings, which discussed the increase in physician services projected to 1990, based on estimates of physicians' hours spent in different practice activities and of number of patients seen. These projections were adjusted to consider changes in physicians characteristics, patient characteristics, behavioral responses of physicians to changing market conditions, and the institutional environment generated by policies of the government and private organizations. Weber's preliminary analysis shows that there will be a 70 percent aggregrate increase in physician-patient contacts between 1976 and 1990 for the specialties studied.

There will be a change in physician behavior brought about by competition, and most patients will welcome the change. However, this change in behavior will also lead to higher costs. Doctors will have to become more competitive to retain their own patients, by having more flexible office hours which accommodate the patient rather than the physician, by spending more time with patients, or by providing more of the amenities that the patients want. Consequently, costs are going to rise, because these are inputs that have not previously been included in charges. Likewise, to the extent that we have a larger number of physicians addressing themselves to many of the problems of the aged, we are going to have considerable increases in costs.

One of the papers yesterday which stimulated a great deal of discussion was on large Medicaid practices. Speaking as someone whose Medicaid practice is probably large in terms of dollar volume (because we are a very large group practice) and small in terms of percentage of work, I find my experience somewhat different from what was cited, particularly with respect to the reported finding that Medicaid payments in the South, which is where I practice, approximated what was reimbursed in the private sector.

That fact is not true in my part of the South. For example, a nearby State has gone out of the Medicaid business entirely as of this month, unless it recently appropriated more funds. The adjacent State seems to deal with its problems by the simple expedient of sending a bill back two months after it was submitted with a notation that they cannot consider it unless you have the grandmother's maiden name or some other bit of trivia. When you send it back in with the grandmother's maiden name, you are then told, "Terribly sorry, this is for services delivered over six weeks ago, and therefore it cannot be considered for payment." Our group practice just reviewed our experience with our State over the past year. We delivered over $1,000,000 worth of services to Medicaid patients and were paid $470,000 for them. This difference is not likely to encourage one to participate in Medicaid in a big way.

In addition to the level of appropriations and the unevenness of the program, one of our problems is related to the fact that we deal with an intermediary, who is hired by the State to process the claims and who gets paid per claim. The result is that it costs us $3 to submit a claim to Blue Cross, $3 to submit one to the Medicare carrier, and $28 to submit a claim to the Medicaid intermediary. My practice is a group and we generate, by computer, a single composite bill for all services delivered by members of the group. The intermediary, which is paid per claim processed, does not acknowledge that the practice is a group, so that we must take the single computerized bill and create by hand a separate bill for each physician who has seen the patient and often for each separate type of service delivered to the patient by the same physician. Our worst example was for a very sick newborn infant who had been in the neonatal intensive care unit. It took 60 pages to file the claim.

These examples are just to point out that there are problems at the State level. I think many of the problems of securing physician participation could be addressed through a more realistic assessment of the rate at which reimbursement is made on behalf of the Medicaid recipients, and others by a diminution of the red tape involved.

I particularly enjoyed Bob Woodward's comments about how to remunerate physicians: output-based payment as opposed to time-based or other things. It is a question of how output can be measured for a variety of services. In some instances, output is a service such as an obstetrical delivery or an appendectomy, but in other specialties output may be viewed as clearly related to time. A comprehensive history and physical takes a certain period of time, and the pricing structure most physicians use takes that amount of time into consideration. The same is true for a day of hospital care. Certainly such outputs as prolonged detention with patients in intensive care units are time-based, and yet they are also measures of what the physician perceives as outputs.

I certainly don't feel that it is reasonable to link payment to outcome. The suggestion was made that perhaps we could go to something like diagnosis related groups (DRGs). I think we would have to have much more experience on the hospital side before I would be able to see whether this scheme would be a reasonable way of compensating for the services in a physician's practice. DRGs were originally designed as part of a study to look at the delivery of hospital services. They have been extracted from that context into a technique for paying for hospital services in certain jurisdictions. When I look back at some of the data, it appears that these DRGs are really not comparable in required inputs for the patient. An awful lot of things that are not necessarily comparable or treated in the same manner in community hospitals and university teaching hospitals are jammed into the same box.

I will wind up my comments by referring to what Bruce Steinwald discussed.[2] I would suggest that one reason that there seems to be a much bigger chunk of income going into retirement programs for hospital-based specialties relates to the particular nature of those specialties. A physician, if incorporated, has a few more options available with respect to tax laws in setting up a retirement program than if he or she is simply self-employed. Self-employed individuals, be

[2]Bruce Steinwald presented data on the practice characteristics, compensation methods, and incomes of hospital-based physicians (HBPs) in the specialties of anesthesiology, pathology, and radiology. He made some comparisons with office-based physicians. The findings supported past research showing that radiology is the most lucrative HBP specialty, followed by pathology and anesthesiology. Also, hospital-based practice tended to be considerably more lucrative than office-based practice, taken as a whole.

they in partnerships or solo practices, are for the most part limited to the Keogh legislation, which puts a ceiling of $7,500 a year on retirement contributions. If a practice is incorporated, the corporation can do much more lavish things for its employees. The corporation must, however, treat all employees alike, physician and non-physician. A group practice, like the one I am in, has about five non-physician employees for each physician, and even if we shifted from a partnership to a corporate status, we would not have enough money to liberalize retirement benefits. Certain hospital-based radiologists, however, can create a corporation which negotiates with a hospital for delivery of radiologic services. The hospital has the employees and the overhead while the professional corporation receives the income from professional services, and since its only employees are the radiologists, the corporation can devise interesting rewards for its employees.

Stanley Wallack, Ph.D., Brandeis University

I concur with many other people who said they found the conference educational. Because each paper has already been reviewed, I would like to make some rather general observations on a select number of papers, discuss what aspects of physician behavior we need to learn more about, and make some suggestions for future research.

Let me begin by emphasizing the timeliness of this conference. Congress and other groups are beginning to look hard for alternatives to increased regulation in the health sector. Because of this new emphasis, economists will be challenged to come up with solutions that address failures of the health services marketplace. Up until now, Alain Enthoven has offered the only option. His solution focuses on HMOs and national health insurance plans, both of which require major changes from the current system. The first idea seeks to change the relevant prices for consumer decision-making and the other the organizations that deliver care. These would certainly make the medical marketplace more conducive to competitive behavior. But others of us must come up with less global solutions which are applicable to the existing financing and organizational arrangements. To do this, we will have to acquire a better understanding of the behavior of existing providers and institutions, or, in our jargon, get inside the "black box." Some of the research presented at this conference contributes to this better understanding, in particular (1) Robert Berry's results on cost differences among practices, (2) Mark Pauly's discussion concerning the effect of hospital inputs on physician productivity, (3) Frank Sloan's ideas about Blue Shield's control over fees, (4) Janet Mitchell's and Jerry Cromwell's evidence that physicians who serve Medicaid patients are different from physicians who serve non-Medicaid patients, and (5) Gerald Weber's projections on the impact of the high increase in physicians.

Another way of judging the relevance of these papers is to ask how they contribute to answering the two current major policy questions on physician behavior. The first is how to pay for physicians' services. How do we move away from paying physicians on (1) a procedure by procedure basis and (2) the basis of usual and customary charges? The second issue is what is going to happen to the health system given the future increase in physicians? These two issues are obviously interrelated, given that the form of reimbursement affects the supply side response. Let me try to make a few points about how the papers helped us in answering these policy questions.

First, as an overall observation, I believe that economists can contribute to the solutions. I also believe that these policy questions go way beyond the tools of the economist and that we need to work with other disciplines in seeking the answers. With regard to the Medicare Economic Index, some questions economists can help answer are: how has it affected overall physicians' fees and incomes; how has it affected specialists' fees and incomes; and how has it affected the differences in rural/urban fees and physicians' incomes? How well have these questions been answered by the research papers? With regard to the overall rate of increase in physicians' incomes and fees, little has been said. It is unclear to me that they have been abated by this policy, that is, whether the total expenditures for Medicare patients, including both the program's and the individuals' outlays, have really been dampened.

With regard to specialty-income differentials, I think some pertinent results have been shown. Berry tells us there are differences in cost shares across specialties, and Mark Pauly has shown how physicians can use the hospital and hospital employees to increase their productivity and income. Since physicians have some latitude in choosing how many services they provide in the hospital and how many in the office, the Index could have permitted the income of specialists who provide more care at the hospital to increase faster.

Where physicians make their money is terribly important, and I have some information to offer from a study I just completed that looked in-depth at a few rural medical practices. In my study I tried to develop revenue and cost centers for the primary care practices. The centers were: the hospital, the nursing home, ancillaries, and the office itself. I found that those practices which were doing relatively well—and here I do not mean annual physician incomes of $80,000, but rather $40,000 to $60,000—had moderate or high levels of hospital encounters. Not only are the average prices higher for hospital encounters, but the costs associated with that revenue are minimal. Future studies need to go beyond the office portion of a practice and look at the entire practice.

With regard to rural/urban fees, I suspect that the Medicare Index has mitigated the differential that would have occurred without the Index. Physician fee differentials are determined, in part, by the rate of increase in physicians. When a physician begins to practice in an area, he or she looks around, finds out the prevailing rate, and says, "Well, I'm certainly not going to price below the 75th percentile because, once I do, my fees are going to stay down there." Because of this, fee increases are likely to be greater in areas that are experiencing a faster increase in physicians. Rural areas have not experienced such growth. This works to keep rural fees down and to widen the urban/rural differential. If we want more physicians to go to rural areas, this is not the result we want. We should learn what effect the Index has had on this differential.

The next question becomes: Is this the path we want to follow in the future? Although the Index was not meant to dissolve the income and fee differentials among specialties and geographic areas, it may have actually exacerbated existing problems because it has maintained the existing underlying differentials.

I think many of us, physicians and analysts, believe that the existing fee structure is inappropriate. Whenever I discuss the issue of fee differentials and their impact at a meeting of physicians, the physicians do not support the existing fee structure and have a very hard time justifying it.

I do not think that the solution to the problem of fee differentials will be provided by economic analyses. We are talking about a very complex problem which involves a number of organizations and for which any solution will yield lots of winners and losers. We have to look for a system and process that can deal with these issues. The economist hopefully would be able to determine the impact of the existing differentials, as well as new ones, but I do not think he or she would be able to tell us how we can restructure them. If we are going to change the way we reimburse physicians, I think we need other disciplines such as political science and sociology to help us deal with some of the organizational relationships.

The amount of discussion on causality at this conference suggests to me how little we know about the behavior of physicians and medical care delivery organizations. I differ with Jack Hadley, who has described how much we have learned about physician behavior. Let me give some examples of our ignorance as it relates to the findings of this conference. I do not understand Steve Dresch's comment that all physicians have monopoly power. There are certainly those economists who argue that the structure of the market is a competitive one with many independent buyers and sellers. To learn whether it is competitive or monopolistic requires analyses on how the physician marketplace works. For example, are physicians able to control or eliminate substitutes in consumption? If so, how?

Expanding on Jerry Weber's paper shows how little we do know about the behavior of medical care organizations. A number of scenarios on the impact of future increases in physicians can be developed. Weber gave us the base line scenario by distributing future physicians according to the current specialty and geographic distributions. Although we could describe many other scenarios, I am not sure we could assign them probabilities and have any sense as to their correctness. There are too many unknowns about physicians' behavior. We do not know, for example, how a new physician starts a practice. I do not think a physician just walks out there, puts up a shingle, and starts receiving patients. We often talk about increases in supply as though physicians are independent firms. But an increase in physicians is a very different thing from an increase in the number of independent firms. Physicians often join existing groups.

We do not know much about the impact of group practices. Does the group act as one firm or is it a number of independent firms? How does it share its revenues and costs? A practice that does not share revenues or costs is probably a very different operation from one that does. I would certainly expect referral patterns to be different, for example. Learning more about referrals may help us to understand the monopoly power of physicians. I would think that a new physician would want to become a complement to existing providers. By being a complement, a physician can try to delineate a market, acquire market clout, and yet not threaten other providers. This would lead one to expect a continuous move to greater sub-specialization. Sub-specialization means you are a complement, and there is derived demand for your services from other sub-specialists. How important is this derived demand in explaining the observed high correlation of physician supply with physician demand?

We do not understand how organizations like Blue Shield operate. They obviously have some control over the marketplace through their decisions on reimbursement, on who is going to be paid, and on what is going to be paid for. But the extent of their control on fees, specialty mix, etc. is still debatable.

And finally, we still do not know very much about why physicians locate where they do. Yesterday, a couple of people mentioned a recent Rand Institute study which used probit analysis to explain where physicians locate. What the study basically shows is that the likelihood of certain specialists locating in communities of smaller size has increased. It is also true that the physician/population distribution by county size has worsened. Again, we do not understand what causes these trends.

My overall point is that we still do not understand a great deal about the organizational and institutional issues that are going to be terribly important when answering questions on the impact of physician supply. On the other hand, I am encouraged by the number of researchers in the field and the quality of the work being done.

If we are going to answer some of the questions I have discussed, we must approach them differently and work with other disciplines. We will need to more closely observe the market if we are to better understand the important institutions. It is easier to use secondary data bases (and I think our ingenious uses of secondary data are to our credit), but to understand that market, we will need to go out there and gather data. This is obviously a very expensive proposition. But I believe there is no other choice available if we are going to offer options for making the existing fee-for-service delivery system more competitive.

Ira Burney, Office of Legislation and Policy

The topics and papers presented in the past two days have been quite diverse. It is a credit to the originality of the researchers that so many analyses can be performed from a single data base.

One of the hazards of being the last person on the summary panel is that many of the comments have already been made by the discussants of individual papers or the rest of the summary panel. Nevertheless, I will run the risk of repetition and offer some policy interpretations from the papers.

To organize my comments, I will consider the papers in two groups: first, those papers that deal with short-term or current policy issues and, second, those that deal with longer-term or more general system reform issues. And as the summary person on the summary panel, I will try to provide a perspective on what these papers mean for physician reimbursement and Federal programs and problems.

While most people may be familiar with some or all of the reimbursement issues, it is worthwhile to begin with an overview. First, physician reimbursement issues are complex. There are more than 400,000 practicing physicians compared with 7,000 hospitals, that is, more than 50 times as many decision-making units. Second, hospital data bases on physicians' fees, incomes, and patterns of medical service are fragmented and uncoordinated. Next, although it is becoming commonplace to talk about the role of the physician in allocating resources in the health care system, it remains a critical point. In 1980, physicians were responsible for directing about $110 billion in health care resources, in addition to the $45 billion spent on physician services.

Third-party coverage for physicians' services differs somewhat from coverage for hospital care; 64 percent of physicians' services are covered by insurance, compared to 92 percent for hospital care. The Federal influence on the physician sector is more limited than on the hospital sector, since Medicare and Medicaid account for only 22 percent of physician expenditures. The Medicare system is even more limited, since it allows physicians to bill beneficiaries on a claim-by-claim basis, instead of accepting as payment-in-full what Medicare pays (less cost-sharing). While there has been much talk over the past two days about structuring proper incentives, there are real limitations to doing so using Federal programs.

A good deal of information is available on physicians' fee patterns, but considerably less is known about the quantity and mix of services rendered or about physicians' relationships to hospital practice. This is an important issue, given the increases in physician supply expected by 1990.

In terms of Federal programs, Medicare uses the customary, prevailing, and reasonable (CPR) charge method to determine how much to pay for specific procedures. (CPR is also known as usual, customary, and reasonable [UCR] within insurance companies.) The CPR charge method reflects existing market rates, and these patterns have been incorporated into the Medicare reimbursement system. About half of the State Medicaid programs use fee schedules, and the other half use the CPR system. In addition, as has previously been discussed, in 1972 Congress mandated use of an Economic Index to limit the increases in Medicare prevailing charges. The Index is a formula based on differences in other practice costs and earnings levels in the general economy.

Given this state of affairs, what are some of the problems with the Medicare and Medicaid reimbursement systems? The existing Medicare system has been criticized for the following reasons: (1) it is confusing to both the beneficiary and the physician; (2) it has resulted in specialty reimbursement differentials for physicians performing the same procedure, and has resulted in urban/rural fee differences of about 23 percent; (3) it has resulted in payment imbalances which favor high technology, surgery, and in-hospital procedures, rather than primary care or ambulatory-based care; (4) it has resulted in inadequate financial protection for the beneficiaries on the 50 percent of claims which are unassigned; and finally, (5) it is becoming a series of specialty-specific, local fee schedules, largely because of the Economic Index. The bottom line is that the Medicare physician reimbursement system contains incentives in all the wrong directions.

The problems of Medicaid are somewhat different, in that the major problem is Medicaid reimbursement levels. In one-third of the States, they are less than 80 percent of Medicare fees, causing reduced access to beneficiaries and discouraging participation by physicians. In addition, there is an interrelationship between Medicaid benefits, eligibility, and reimbursement. States with high Medicaid reimbursement levels relative to Medicare, for example, tend to have more restrictive benefit and eligibility policies.

What do these papers really mean for policy and, particularly, for the Medicare and Medicaid programs? Of the four papers dealing with short-term or current policy, I will begin with the paper by Robert Berry on variations in practice costs among specialties. As has been pointed out, the Economic Index is applied as a single national number without specialty or other distinctions because of the lack of available data. Berry's analysis of the survey data provides a basis for evaluating practice cost differentials and the effect on the Index of incorporating specialty-specific costs.

If the differences in absolute magnitude are not large, as Berry's paper suggests, even though they are statistically significant, would the administrative expenses of more complex systems offset the potential benefits? (Berry's numbers show about a 1 percent differential in 1982 among the three specialty groupings.) Second, Berry suggests that if specialty groupings were used, surgery and surgical specialties would have larger rates of increase than general and family practice, internal medicine, and medical specialties. Given all the existing incentives that reward surgery relative to primary care, should these incentives for surgery, even though small, be accepted?

Third, it is necessary to look at the link between cost differences and reimbursement differences under either a CPR system or a fee schedule, particularly if the concept of "equal pay for equal work" is accepted as a policy goal. Assuming "equal work" can be defined, these findings tend to support "equal pay," at least from the aspect of practice cost.

The paper by Frank Sloan explores the effects of physicians' involvement in Blue Shield plans on reimbursement and participation. His results are supportive of those arrived at by the Federal Trade Commission, that is, that physician control of Blue Shield boards and substantive committees leads to higher reimbursement amounts. The issue is important from a HCFA perspective because Medicare and Medicaid use Blue Shield plans as fiscal agents and because increases in private reimbursement tend to decrease the access to care for Medicare and Medicaid patients.

One can take a different perspective on these findings and ask what the mechanism is by which physician control of Blue Shield boards and committees affects payment rates. What role does the board have in setting payment rates? What exactly do the substantive committees do to set higher reimbursement rates? Does physician control of the boards and committees, or physician use of the UCR payment mechanism, lead to higher fees? After all, physicians can influence current and future reimbursement levels under the UCR system so that where UCR coverage is more prevalent, it is easier to achieve higher reimbursement levels. This question is important for Medicare because it relies on a UCR system, although the reimbursement principles are more uniformly and rigorously defined at the national level. Consequently, I would like to register a note of caution about pursuing regulatory policies before we have a better understanding of what actually occurs.

The paper by Jan Mitchell and Jerry Cromwell really flies in the face of conventional wisdom about Medicaid mills and access to care for Medicaid patients. It is giant step toward producing some hard evidence that large Medicaid practices do not universally merit the negative connotations of a "mill." The point was made yesterday that the exclusion from the survey of physician groups larger than 10 was not expected to influence the results. However, one must wonder if, indeed, the real "mills" responded to the survey. It would also be interesting to know more about the other kinds of patients served by the large Medicaid practices. Are they Medicare patients, low-income patients, insured patients?

I think there are several lessons to be learned from this paper. First, perceptions of Medicaid mills that were shaped by Senator Moss' investigations or the GAO study of eight practices may indeed have been shaped by very selective samples of a few problem practices in one or two cities where the litany of abuses did occur. These real "mills" may have co-existed with a much larger number of large Medicaid practices of the character that Mitchell and Cromwell found. If these studies had focused on other geographic areas, they may have found very different things. The point is that perceptions which lead to wholesale condemnation of a major public program really need to be based on solid data and comprehensive analysis.

Second, the study shows that Medicaid may not be as bad as wide criticism suggests. Medicaid patients do have access to physicians. At the same time, the results do show that it is a program apart from mainstream medicine, served by physicians with fewer credentials. Clearly, this was not one of the original intentions of Medicaid.

The point was made yesterday that improvements in Medicaid benefits and reimbursement levels would be hard to justify because of the lack of adequate data on the real access problems of Medicaid patients. What this statement really suggests is that we need to know much more about access to care for Medicaid patients, particularly about where they receive care and the quality and kinds of care they actually get.

Bruce Steinwald should be commended for undertaking an analysis of hospital-based physicians (that is, radiologists, pathologists, and anesthesiologists). It is one of the most complicated aspects of Medicare reimbursement because of the multiplicity of billing arrangements and because of the separation between Parts A and B of Medicare and between technical and professional components. Steinwald compared the adjusted net income per hour of medical activity for fee-for-service, hospital-based physicians with that for fee-for-service, office-based physicians. His finding that fee-for-service pathologists and radiologists can earn 50 percent more than fee-for-service, office-based physicians is significant. It has broad implications for the relative incentives in the existing reimbursement system for specialization, hospital practice, and certain types of services.

The other major lesson from Steinwald's paper concerns Medicare's impact on the health care system. Federal policy may have caused some of the current reimbursement problems by requiring a separation of physician and hospital components. Prior to Medicare, separate fee-for-service billing for pathologists and radiologists was uncommon.

As to the papers dealing with the longer-term or general systems reform issues, one of the biggest issues that must be faced in the next decade is the increase in the number of physicians. There were four papers that dealt with some aspect of this increase.

Jerry Weber's analysis is an important first step in delineating this growth in terms of physician service capacity and expenditures. While some of the base line projections of physician visits, hours, and system expenditures are staggering, they are just the starting point.

As Weber pointed out, the exact nature of this increase in physicians and service capacity will depend on physician and patient characteristics, the behavioral response of physicians, and the public/private institutional environment. Clearly, more work is needed to analyze these factors to determine if there really will be a 50 percent increase in the number of physician visits *per capita* by 1990. From the perspective of the financing programs, this increase demands a structuring of reimbursement incentives to promote socially desirable outcomes.

Mark Pauly's paper pointed out the need to consider linkages in the health care system, particularly between physicians and hospitals and between hospital inputs and physician productivity and fee levels. As the number of physicians increase in the next decade, if hospital capacity remains relatively constant, more physicians will be competing for fewer hospital resources. What will be the implications of a differential rate of growth in the two sectors?

Another implication of the Pauly paper is the need to design physician reimbursement policies that are consistent with hospital reimbursement policies. In the longer term, this may be accomplished with per case or per episode methods of reimbursement which include both hospital and physician resources. This is another area needing additional work.

The paper by Steve Dresch also relates to the future supply of physicians. After all, the rate of return is really one factor which affects the flow of students to medical careers. The rates of return which he calculates, even when adjusted for hours differences and for the adoption of a full-cost tuition, are considerable. A $5,000 to $10,000 annuity for choosing to become a physician rather than some other professional is quite substantial.

Earlier today, a panel member made a number of comments about why those rates of return may be overestimated. However, a reason why they may be underestimated was overlooked. Unlike Federal bureaucrats and most other workers who can sell only 40 hours per week to their employers, physicians, as independent practitioners, have an ability to sell the 41st hour. The ability to sell the marginal hour is likely to be of some value to the physicians. Also Dresch's numbers have some relevance to current manpower legislation. Given the expected increases in physician supply with possible commensurate increases in physician incomes, the substantial rates of return to medical education suggest that medical education subsidies could be eliminated and the burden of financing transferred to the student.

In the long term, we have to address the issue of how much physicians should make, at least from the reimbursement perspective. This is a judgment about which economists and policymakers are typically uncomfortable. However, if some kind of fee schedule were adopted with appropriate relative values, the issue of how the whole reimbursement structure should be priced would remain. Presumably, rates of return would be incorporated into such decisions.

The paper by Doug Brown has relevance for future physician supply issues because, if physicians are now actually over-employing certain aides, the large numbers of physicians expected to come out of the pipeline may force physician assistants out of the labor market. We may be training people for jobs that will not exist.

In conclusion, the conference demonstrates that, while we have learned a lot, we still need to learn much more. The papers are important from the policy perspectives that I defined earlier, but there is still more that needs to be done. Improved information is essential to design effective policies. As some of the papers pointed out, poorly designed policies may have unexpected or unintended consequences which may result in future problems. Finally, given the increase in physician supply, the price of poorly designed policies may be even more substantial.

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